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MULTIPLE SCATTERING TREATMENT FOR USE IN TEL LOWTRAN AND FASCODE MODELS

R. G. Isaacs W.-C. Wang R. D. Worsham S. Goldenberg



Atmospheric and Environmental Research, Inc. 840 Memorial Drive Cambridge, Massachusetts 02139

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An evaluation of available approaches to treat the coupled processes of multiple-scattering due to atmospheric molecules and aerosols, and nongray absorption due to atmospheric gases is performed. Based on the evaluation and consideration of the requirements of efficiency, accuracy and code structure of LOWTRAN and FASCODE models, we recommend that an approach based on the stream approximation together with the k-distribution method is best suited					

for implementation into these models. The parameterization is unique in the

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sense that the k-distribution method decouples the multiple-scattering from the treatment of non-gray gaseous absorption so that the stream approximation can be used to treat multiple scattering in both the LOWTRAN and FASCODE models. The stream approximation is extremely attractive since it retains the analytical simplicity (and hence, efficiency) of single scattering while improving the treatment of multiple-scattering (and hence, accuracy). Therefore, the parameterization is a uniform approach for solar, thermal and microwave regimes and can provide a general methodology to treat multiple-scattering due to aerosols, clouds and precipitation in the presence of gaseous absorption within the LOWTRAN/FASCODE formalism.

Calculations are performed to compare the accuracy of the stream approximation to numerical multiple scattering treatments for solar, thermal, and microwave spectral regions. Results indicate the approach can achieve RMS accuracies of about 20 percent in radiance for domains of optical properties characteristic of realistic atmospheric models.

The multiple scattering parameterization is implemented in both FASCODE and LOWTRAN models. FASCODE and LOWTRAN multiple scattering radiance results are compared to exact treatments. These results indicate that the new multiple scattering versions of these models provide more accurate simulations of the path dependent radiance than do their nonscattering counterparts. To insure consistency, multiple scattering versions of LOWTRAN and FASCODE are compared to one another.

Finally, recommendations are presented to further exploit the capabilities introduced here.

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- FASCODE TEST CASE
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#### 1. INTRODUCTION

#### 1.1 Background

Optimal design and deployment of electro-optical (EO) remote sensing and communication systems requires accurate modeling and prediction of the effects of the ambient environment on atmospheric transmission. Atmospheric transmittance/radiance models such as AFGL's LOWTRAN (Kneizys et al., 1983) and FASCODE (Clough et al., 1986) have been developed within this context to provide the capability to assess potential adverse environmental impacts on EO system performance.

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In order to accurately predict atmospheric effects on the propagation of visible, infrared and microwave radiation, it is necessary to treat the extinction mechanisms including molecular scattering and absorption, and particle (aerosols, clouds and precipitation) scattering and absorption, characterizing the ambient atmosphere. In the present AFGL transmittance/radiance models, these processes are adequately included in the treatment of path transmission. However, simplified treatments are employed to simulate the effects of scattering on the calculation of radiance. For thermal infrared and microwave radiation, for example, particle scattering in LOWTRAN has been treated as an enhancement to extinction but not as a source term. This approach leads to an underestimate of radiance for paths where multiple scattering is important (Ben-Shalom et al., 1980). LOWTRAN uses the single scattering approximation for evaluating solar radiances (Ridgway et al., 1982). While the single scattering implementation is straightforward, its application introduces errors which are functions of wavelength, sun/sensor geometry, and surface optical properties (cf. Isaacs and Ozkaynak, 1980; Dave, 1981). These errors are primarily due to neglecting higher order scattering and surface reflection. In FASCODE, particle scattering has been treated as equivalent to absorption. All scattered radiation is thus re-emitted as if it were absorbed, i.e., the scattered radiation is conserved. This conservative scattering approach can lead to an overestimate of radiance.

In order to provide a more realistic simulation of radiation in spectral regions and along atmospheric paths where multiple scattering (MS) is a significant contribution to the source function, an efficient and accurate scattering parameterization has been incorporated into the LOWTRAN and FASCODE models.

## 1.2 Objective of the Present Study

A two-year research program supported by AFGL/OPI was undertaken at Atmospheric and Environmental Research, Inc. (AER). The overall program objective was to incorporate a uniform, compatible, accurate and efficient multiple scattering scheme into the present LOWTRAN/FASCODE models so that the multiple scattering effects due to particulates could be realistically treated. The first phase of the program was to study and evaluate the available multiple-scattering parameterizations and recommend the most appropriate one for its incorporation into the transmittance/radiance models. Constraints of efficiency, accuracy, and code structure of LOWTRAN/FASCODE were the key considerations of the evaluation processes. The results of a trade-off analysis to determine an appropriate approach are summarized in Appendix A. The second phase of the study was to implement the most suitable multiple scattering parameterization into the LOWTRAN and FASCODE models, test the resulting multiple scattering versions and document the codes.

This report summarizes the work accomplished in the second phase of the overall effort. Following this introduction, the selected approach for multiple scattering is described in detail (Section 2). In Section 3, the implementation of the multiple scattering parameterization within the LOWTRAN/FASCODE models is discussed in detail. Comparisons of the implemented code are made to exact treatments and to one another in Section 4. Finally, recommendations are provided in Section 5 for enhancing the multiple scattering capability provided here.

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#### 2. MULTIPLE SCATTERING APPROACH

## 2.1 Stream Approximation

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Selection of an appropriate treatment of multiple scattering (MS) for application to the LOWTRAN and FASCODE models is severely constrained by competing requirements of desired efficiency and accuracy, and limitations imposed by the inherent code structures of these models. Additionally, it is desired to provide an approach which is uniformly applicable to all spectral regions considered and equally appropriate for implementation within both LOWTRAN and FASCODE. Based on these considerations, the MS parameterization selected consisted of a finite stream approach (using two streams for simplicity) to approximate the scattering source function.

This approach could be implemented directly in FASCODE since it is essentially a monochromatic calculation. It is known, however, that there exist difficulties in calculating the transmittance/radiance averaged over a finite spectral interval in a nongray gaseous absorber with multiple scattering because the commonly-used band models are not applicable (cf. Stephens, 1984). Such is the case for implementing an MS treatment within LOWTRAN. The best approach to solve this problem is the use of the k-distribution method, which decouples the multiple scattering from the gaseous spectral integration so that the available (monochromatic) multiple scattering algorithms can be used directly. For LOWTRAN, the stream approximation is performed through an interface routine consisting of the k-distribution method. For practical purposes, this consists of decomposing the band model determined optical properties into a set of equivalent monochromatic calculations which are then summed to give the spectrally averaged results. The configuration of the multiple scattering approach for LOWTRAN and FASCODE is summarized in Figure 2-1.

As mentioned earlier, the multiple scattering parameterization has to be accommodated by the present LOWTRAN and FASCODE code structures. This constraint is particularly important for FASCODE. In the FASCODE application, gaseous absorption is evaluated directly from the line-by-line calculation. Fluxes required for the stream approximation are calculated via the parameterized adding method. The adding method is particularly consistent with the code structure of both radiance/transmittance models since they treat one layer at a time.

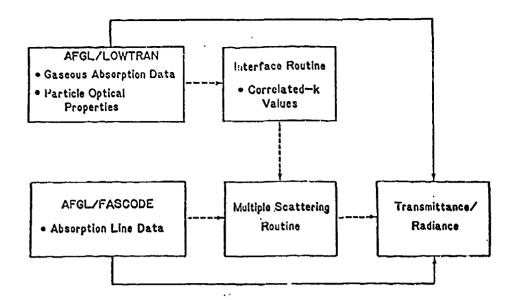


Fig. 2-1. AFGL transmittance/radiance code structure -- present models (solid line) with MS parameterization (dashed line).

In the FASCODE model, for example, the evaluation of layer optical properties always commences with that level in the selected path with the highest pressure and the selected spectral sampling interval decreases with pressure. This approach insures that the layer spectral resolution is consistent with the decrease of Voight line widths at higher altitudes. From the perspective of the line-by-line calculation, this method is computationally quite efficient. However, it is inconsistent with monochromatic multiple scattering treatments. In order to accommodate the sampling requirements of both the line-by-line and multiple scattering calculations, the FASCODE implementation employs the adding formalism to aid in the merging of the scattered fluxes from successive layers.

## 2.2 Theory

We provide a generic outline of the basic theory here. This prescription is modified slightly for specific application to the LOWTRAN and FASCODE models. Details of the specific model implementations are described in Section 3.

#### 2.2.1 Radiance and Source Function

The desired radiance  $I_{\nu}$  at wavenumber  $\nu$  for an arbitrary path with zenith angle cosine and azimuth angle  $(\mu,\phi)$  is given by the solution to the radiative transfer equation (RTE):

$$\mu \frac{\mathrm{d}}{\mathrm{d}\tau} I_{V}(\tau,\mu,\phi) = I_{V}(\tau,\mu,\phi) - J_{V}(\tau,\mu,\phi). \tag{2.1}$$

Here  $\tau_{\nu}$  is the optical thickness,  $\mu$  is then cosine of the path zenith angle, and  $\phi$  is the azimuth angle relative to the sun's azimuth. Vertical optical depth,  $\tau_{\nu}$ , will depend on the relevant mechanisms determining the extinction of electromagnetic radiation for the spectral region characterized by wavenumber,  $\nu$ . In general these mechanisms include: (a) molecular absorption,  $k_a$ , (b) molecular scattering,  $k_s$ , (c) particulate absorption,  $\sigma_a$ . and (d) particulate scattering,  $\sigma_s$ . Optical depth is given by integrating the relevant vertical extinction coefficient profiles according to:

$$\tau_{v}(z) = \int_{z}^{\infty} \left[ k_{a}(z) + k_{s}(z) + \sigma_{a}(z) + \sigma_{s}(z) \right] dz$$

The general source function,  $J_{\nu}$ , including scattering of solar radiation and thermal emission, is given by:

$$J(\tau,\mu,\phi) = J_{O}(\tau,\mu,\phi) + J_{MS}(\tau,\mu,\phi)$$
 (2.2)

where

$$J_{O}(\tau, \mu, \phi) = \frac{\omega_{O}(\tau)}{4\pi} \pi F e^{-\tau/\mu_{O}} P(\Omega; -\Omega_{O}) + [1-\omega_{O}(\tau)] B[\Theta(\tau)]$$
(2.3)

and

$$J_{MS}(\tau,\mu,\phi) = \frac{\omega_{O}(\tau)}{4\pi} \int_{\Omega} P(\Omega;\Omega') I(\tau,\Omega') d\Omega'. \qquad (2.4)$$

Here,  $\omega_0$  is the single scattering albedo, P is the appropriate angular scattering of phase function, and B is the Planck function at temperature 0. The extraterrestrial solar irradiance is given by F and the path and solar directions are given by  $\Omega$  and  $\Omega_0$ , respectively. The first term in Equation (2.3) is the single scattering of solar radiation while the second is the local thermal emission.

Radiance solutions to the RTE (Eq. (2.1)) are subject to boundary conditions at the top of the atmosphere ( $\tau = 0.0$ ) for downward radiance and at the earth's surface ( $\tau = \tau^*$ ) for upward radiance. At  $\tau = 0.0$ , downward diffuse radiance from space is zero (the direct solar irradiance is accounted for via the primary source function) resulting in:

$$I_{b}(0, -\mu, \phi) = 0.0 \tag{2.5}$$

(At millimeter wave frequencies a contribution due to emission at the cosmic background effective temperature of 2.7 K may be included when high accuracy is required.)

Boundary conditions at the surface will depend on the nature of the surface reflectance/emittance properties. The most common assumption is that of Lambert reflectance, i.e. the upward isotropic flux given by a constant surface albedo, r, times the downward flux. Upward and downward fluxes  $F^{\pm}(\tau)$  at optical depth  $\tau$ , are defined respectively as:

$$F^{\pm}(\tau) = \int_{0}^{2\pi} \int_{0}^{1} I(\tau, \pm \mu, \phi) \mu d\mu d\phi \qquad (2.6)$$

This results in a lower boundary condition upward radiance of:

$$I_{b}(\tau^{*},\mu,\phi) = \frac{r}{\pi} \left[ \pi F_{\mu} \exp(-\tau^{*}/\mu_{o}) + \int_{0}^{2\pi} \int_{0}^{1} I(\tau^{*},-\mu,\phi) \mu d\mu d\phi \right] + (1-r) B[T_{s}]$$
 (2.7)

The three terms on the R.H.S. of (2.7) are respectively: (a) reflectance of attenuated solar irradiance (in UV, visible, near IR spectral regions), (b) reflectance of downward scattered radiance field, and (c) thermal emission due to the surface at temperature,  $T_s$ . The surface emissivity is unity minus the surface albedo, i.e., (1-r). LOWTRAN requires that the surface albedo be specified, while FASCODE asks for the surface emissivity.

General radiance solutions to the RTE for upward and downward radiances, respectively, are:

$$I(\tau, +\mu, \phi) = I_b(\tau^*, \mu, \phi) e^{-(\tau^* - \tau)/\mu} + \int_{\tau}^{\tau^*} J(t, \mu, \phi) e^{-(t - \tau)/\mu} \frac{dt}{\mu}$$
 (2.8)

$$I(\tau, -\mu, \phi) = I_b(0, -\mu, \phi) e^{-\tau/\mu} + \int_0^{\tau} J(t, \mu, \phi) e^{-(\tau - t)/\mu} \frac{dt}{\mu}$$
 (2.9)

where the  $I_b$  are given by the boundary conditions (2.7) and (2.5) above, respectively. Incorporating these boundary conditions, the radiance solutions become:

$$I(\tau,\mu,\phi) = \left\{ \frac{r}{\pi} \left[ \pi \mu_0 F e^{-\tau * / \mu} o + \int_0^1 \int_0^{2\pi} I(\tau *, -\mu, \phi) \mu d\mu d\phi \right] + (1-r) B[T(\tau *)] \exp(-(\tau * -\tau) / \mu + \int_0^1 J(t,\mu,\phi) e^{-(t-\tau) / \mu} \frac{dt}{\mu} \right]$$
(2.10)

$$I(\tau, -\mu, \phi) = \int_{0}^{\tau} J(t, \mu, \phi) e^{-(\tau - t)/\mu} \frac{dt}{\mu}$$
 (2.11)

In the stream approximation, the multiple scattering contribution to the source function (Eq. (2.4) above) is approximated by assuming constant scattered radiances  $I^+$  and  $I^-$  over upward ( $\Omega^+$ ) and downward ( $\Omega^-$ ) hemispheres, respectively, or from Eq. (2.4):

$$J_{MS}(\tau,\mu,\phi) \simeq \frac{\omega_{O}(\tau)}{4\pi} \left[ I^{+}(\tau) \int_{\Omega^{+}} P(\Omega,\Omega^{+}) d\Omega^{+} + I^{-}(\tau) \int_{\Omega^{-}} P(\Omega,\Omega^{-}) d\Omega^{-} \right].$$
(2.12)

Integrating over the angular scattering functions for the resulting azimuthally averaged backscatter fractions,  $\beta(\mu)$ , as a function of zenith angle cosine and substituting the corresponding fluxes:

$$I^{\pm}(\tau) = F^{\pm}(\tau)/\pi$$
 (2.13)

results in

$$J_{MS}(\tau, \pm \mu, \phi) \simeq \frac{\omega_0(\tau)}{\pi} \left\{ F^{\pm}(\tau) [1 - \beta(\mu)] + F^{\mp}(\tau) \beta(\mu) \right\}. \tag{2.14}$$

This simple expression for the multiple scattered contribution to the source function is added to the single scattering and thermal emission contributions for the general source function, J (Eq. (2.2)). The source function is then integrated along with the desired path (as in Eqs. (2.10) or (2.11)) to obtain the desired total radiance including the approximated MS contribution.

The evaluation of the approximated MS source function (Eq. (2.14)) requires local fluxes  $F^+$ ,  $F^-$ , backscatter fractions,  $\beta(u)$ , and single scattering albedos,  $\omega_0$ . The backscatter fractions are given as functions of zenith angle cosine and asymmetry factor by Wiscombe and Grams (1976) (see Figure 2-2). A small error is introduced by assuming these backscatter fractions for the equivalent Henyey-Greenstein phase function rather than integrating the actual function. The single scattering albedo,  $\omega_0(\tau)$ , for a given layer with total optical thickness  $\Delta \tau$  is:

$$\omega_{O}(\tau) = \Delta \tau_{g} / \Delta \tau \tag{2.15}$$

where  $\Delta \tau_s$  is the total scattering optical thickness of the layer. Discretizing equation (2.14) for a given layer, N, the contribution of multiple scattering is approximated as:

$$J_{SA}^{N}(\pm \mu) = J_{O} + \frac{\omega_{O}^{N}}{\pi} \left\{ F_{N}^{\pm} \left[ 1 - \beta^{N}(\mu, g^{N}) \right] + F_{N}^{\mp} \beta^{N}(\mu, g^{N}) \right\}.$$
(2.16)

Here the fluxes are taken as the layer mean quantities evaluated at a level halfway through the layer. The asymmetry factor, g, is a measure of the directional scattering and can be evaluated from the phase function.

Once the source function is approximated, the path radiance can be evaluated. Along a path consisting of layers (N) and the layer above (N+1) with transmissions  $T_N$  and  $T_{N+1}$ , respectively, for example, the emission, E, depends on the path integral of the total source function:

$$E_{N+1}^{+} = E_{N}^{+}T_{N+1} + J_{SA}^{N+1}(+\mu)(1-T_{N+1})$$
 (2.17)

for downward looking and

$$E_{N+1}^- = E_N^- + (1-T_{N+1}) J_{SA}^{N+1} (-\mu) T_N$$
 (2.18)

for upward looking, where the intrinsic layer emission is

$$E_N^{\pm} = (1 - T_N) J_{SA}^N(\pm \mu).$$
 (2.19)

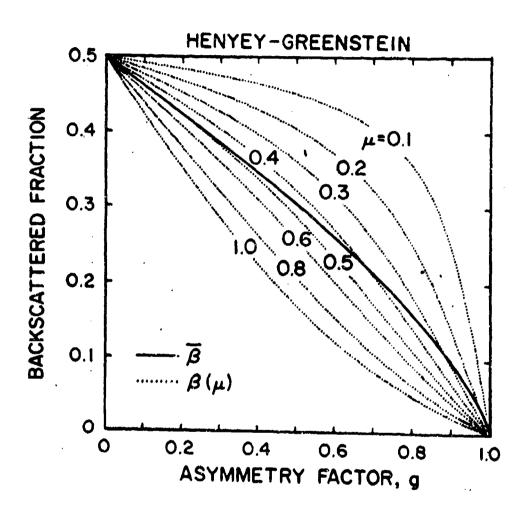


Figure 2-2. Backscattered fractions  $\overline{\beta}$  and  $\beta(\mu)$  for the Henyey-Greenstein phase function versus the asymmetry factor g for a range of values of  $\mu$  (Wiscombe and Grams, 1976).

#### 2.2.2 Layer Fluxes

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Fluxes approximate the required radiances for evaluation of the multiply scattered source function. Upward and downward fluxes (F<sup>+</sup> and F<sup>-</sup>, respectively) for individual isolated layers are evaluated using an appropriate flux parameterization. For example, for solar scattering, the hybrid modified delta eddington approximation (Meador and Weaver, 1980) is used. The chosen flux parameterization also provides intrinsic layer reflection and transmission functions, R and T. These fluxes are calculated using standard two stream parameterization approaches. To accommodate the flux parameterizations, optical properties for the whole atmosphere (i.e., surface to space) are required. The approach for calculating fluxes thus consists of two steps: (1) evaluating local layer (i.e., intrinsic) fluxes for each atmospheric layer, and (2) combining these to obtain the actual flux profiles using the adding method.

Upward and downward layer fluxes for solar radiation are given by:

$$F^{+} = Ae^{k\tau} + Be^{-k\tau} + Ce^{-\tau/\mu}o$$
 (2.20)

$$F^{-} = \frac{1}{\gamma_2} \left\{ A(\gamma_1 - k) e^{k\tau} + B(\gamma_1 + k) e^{-k\tau} + Y e^{-\tau/\mu} o \right\}$$
 (2.21)

where the appropriate constants are given by:

$$k = (\gamma_{1}^{2} - \gamma_{2}^{2})^{1/2}$$

$$A = [B(\gamma_{1}+k) + Y]/(k-\gamma_{1})$$

$$B = (E_{1}e^{k\tau^{*}} + E_{2}e^{-\tau^{*}/\mu_{0}})/(E_{3}e^{k\tau^{*}} + E_{4}e^{-k\tau^{*}})$$

$$C = \pi\omega_{0} \{\frac{\beta(\mu_{0})}{\mu_{0}} - \gamma_{1}\beta(\mu_{0}) - \gamma_{2}[1-\beta(\mu_{0})]\}(\frac{\mu_{0}^{2}}{1-k^{2}\mu_{0}^{2}})$$

$$Y = C(\gamma_{1} + \frac{1}{\mu_{0}}) - \pi F\omega_{0}\beta(\mu_{0})$$
(2.22)

$$E_{1} = Y[1/(\gamma_{1}-k) - r/\gamma_{2}]$$

$$E_{2} = [-C + \pi F \mu_{o} r + \frac{rY}{\gamma_{2}}]$$

$$E_{3} = (\gamma_{1} + k)[1/(k-\gamma_{1}) + r/\gamma_{2}]$$

$$E_{4} = [1 - r(\gamma_{1} + k)/\gamma_{2}]$$

$$Y_{1} = \frac{-\{1-g^{2}-\omega_{o}(4-3g)-\omega_{o}g^{2}(4\beta_{o}+3g-4)\}}{4\{1-g^{2}(1-\mu_{o})\}}$$

$$Y_{2} = \frac{\{7-3g^{2}-\omega_{o}(4+3g)+\omega_{o}g^{2}(4\beta_{o}+3g)\}}{4\{1-g^{2}(1-\mu_{o})\}}$$

Here, r is the Lambert surface albedo and the solar zenith angle cosine is  $\boldsymbol{\mu}_{\text{c}}$ 

The transmission and reflection functions used later in the flux adding are given by:

$$R = F^{+}/\mu_{0}^{\pi}F$$

$$T = F^{-}/\mu_{0}^{\pi}F + \exp^{(-\tau/\mu)}$$
(2.24)

For the thermal fluxes, a linear Planck function relation across an atmospheric layer is used. In so doing, the parameterized two-stream solutions for emission from the layer top and layer bottom, and for total transmission and reflection are

$$F^{+} = a(PB_{t} - mQ - B_{b})/D$$

$$F^{-} = a(PB_{b} + mQ - B_{t})/D$$

$$T = a/D$$

$$R = uv(e^{\tau} - e^{\tau})/D$$
(2.25)

where  $B_t$  and  $B_b$  are the Planck intensity at the layer top and bottom and

$$a^{2} = 1 - \omega_{0}$$
 $m = (B_{b} - B_{t})/\tau$ 
 $P = ve^{\tau_{1}} + ue^{-\tau_{1}}$ 
 $Q = ve^{\tau_{1}} - ue^{-\tau_{1}} - a$ 
 $Q = v^{2}e^{\tau_{1}} - u^{2}e^{-\tau_{1}}$ 
 $u = (1-a)/2$ 
 $v = (1+a)/2$ 
 $\tau_{1} = \sqrt{3}$  at

The optical thickness  $\tau$  and the single scattering albedo  $\boldsymbol{\omega}_{0}$  are given by

$$\tau = ku + \tau_s(1 - g) + \tau_a$$

$$\omega_0 = \tau_s(1 - g)/\tau$$
(2.27)

Here k is the gas absorption coefficient (for a particular wavelength and probability interval), u is the gas amount,  $\tau_8$  is the scattering optical thickness,  $\tau_a$  is the absorption optical thickness and g is the asymmetry factor for the particulate matter in the layer.

#### 2.2.3 Flux Adding Method

To obtain the actual flux profile throughout the atmosphere, intrinsic layer fluxes are combined algebraically using the adding method. In this method, fluxes, reflections, and transmissions are used to add individual layers together. Composite upward fluxes,  ${}^1F_N^+$ , and reflection functions  $R_N^+$ , obtained upon adding two isolated layers, N and (N-1) are given by:

$${}^{1}F_{N}^{+} = F_{N}^{+} + T_{N} ({}^{1}F_{N-1}^{+} + F_{N}^{-}R_{N-1}^{+}) ({}^{1} - R_{N}R_{N-1}^{+})^{-1}$$
(2.28)

$$R_N^+ = R_N^- + R_{N-1}^+ T_N^2 (1 - R_N^- R_{N-1}^+)^{-1}.$$
 (2.29)

Analogous equations provide composite downward fluxes and reflection functions,  ${}^1F_N^-$  and  $R_N^-$ , respectively. The composite upward and downward fluxes provide the actual upward and downward fluxes at layer interfaces including the effects of all layers above and below. For example, the upward and downward fluxes at the boundary between layers N and (N+1) are given by:

$${}^{2}F_{N}^{+} = ({}^{1}F_{N}^{+} + {}^{1}F_{N+1}^{-}R_{N}^{+})(1 - R_{N}^{+}R_{N+1}^{-})^{-1}, \qquad (2.30)$$

$${}^{2}F_{N+1}^{-} = ({}^{1}F_{N+1}^{-} + {}^{1}F_{N}^{+}R_{N+1}^{-})({}^{1}-R_{N}^{+}R_{N+1}^{-})^{-1}.$$
(2.31)

Once obtained, these fluxes are substituted into Eq. (2.16) above to provide the approximation of the MS source function.

#### 2.2.4 Band model considerations

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For LOWTRAN, it is necessary to integrate the spectral radiance values over a finite spectral interval (~ 20 cm<sup>-1</sup>). The basic problem encountered in the calculation of radiative transfer in low spectral resolution in a hazy or cloudy atmosphere is the coupling between the processes of scattering and absorption due to cloud/aerosol particles and absorption by atmospheric gases. The main difficulty is that the integration over frequency cannot be properly accounted for by the usual band model technique for gaseous absorption because they do not allow for multiple-scattering. A direct line-by-line integration over frequency would be very time consuming. One alternative way of carrying out the frequency integration is to use the "k-distribution method" for homogeneous layers (Arking and Grossman, 1972) and the "correlated k-distribution approximation" for inhomogeneous atmospheres (cf. Wang and Ryan, 1983).

For gaseous absorption, the k-distribution method is comparable to line-by-line calculations (Arking and Grossman, 1972). This method is equivalent to the exponential-sum fitting method (see Wiscombe and Evans, 1977) and to the path length distribution method (see Bakan et al., 1978). However, in general, the latter two methods use scaling approximations to account for atmospheric inhomogeneity while the correlated-k approximation assumes certain relationship between k values at different pressure and temperature levels. The accuracy of the approximation is excellent for the 9.6  $\mu$ m 03 band thermal radiation calculations (see Lacis et al., 1979).

Yamamoto et al. (1970, 1971) used finite sums of exponentials to describe the non-gray nature of water vapor absorption and carried out solutions of the equation of transfer for homogeneous band layers using both Chandrasekhar's principles of invariance as well as the discrete ordinate technique. Both techniques require extensive numerical calculations. On the other hand, two-stream approximations together with the correlated-k approximation have been used to study the radiative effects of aerosols (see Hansen et al., 1980). As best summarized recently by Stephens on efficient and accurate radiation parameterizations (1984, p. 862 of the paper): "... only the k-distribution approach can be readily incorporated into scattering models..."

In a homogenous gas layer, the k-distribution function is formerly related to the mean transmission function  $T_{\Lambda\nu}(u)$ ,

$$T_{\Delta \nu}(u) = \frac{1}{\Delta \nu} \int_{\Delta \nu} e^{-ku} d\nu = \int_{0}^{\infty} f(k)e^{-ku}dk$$

$$= \int_{0}^{1} e^{-ku}dg = \sum_{i=1}^{n} e^{-k_{i}u}\Delta g_{i}$$
(2.32)

where  $\Delta \nu$  is the narrow repeated interval (20 cm<sup>-1</sup> in LOWTRAN) and u is the gas amount. The f(k) for a given gas at a specified  $\Delta \nu$  is the probability density function such that f(k)dk is the fraction of the frequency interval for which the absorption coefficient is between k and k+dk. Eq. (2.32) reveals that the transmission depends on the distribution of k-values within  $\Delta \nu$ , but not on the ordering of the values. The cumulative k-distribution function is g(k), while  $(k_1, \Delta g_1)$  are the discreet sets of values to approximate the integral.

By expressing the band model transmission as the sum of exponentials, the multiple scattering calculation for each component can be performed independently as if it were a monochromatic problem. These are weighted and summed (as in Equation (2.32) to recover the essential band model character of the problem.

The fit of Wiscombe and Evans (1977) has been used for the two LOWTRAN transmission functions of water vapor/uniformly mixed gases, and ozone. The accuracy of the fitting is in general within a few percent for T > 0.1. For inhomogeneous atmospheres, we adopt the same scaling approximation used in LOWTRAN, i.e.,

$$k_{i}(P,0) = k_{i}(P_{o},\theta_{o}) \frac{P}{P_{o}} \sqrt{\frac{\theta_{o}}{\theta}}.$$
 (2.33)

where  $\theta_{o}$ ,  $P_{o}$  are reference temperatures and pressures, respectively.

#### 3. IMPLEMENTATION OF MULTIPLE SCATTERING PARAMETERIZATION

## 3.1 FASCODE Implementation of the Stream Approximation for Multiple Scattering

#### 3.1.1 Overview

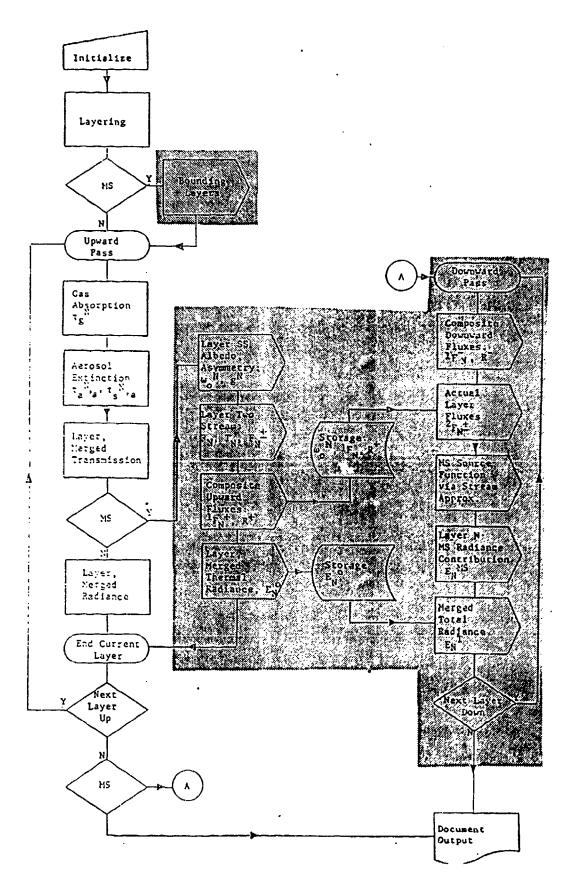
The existing code structure of the FASCODE line-by-line algorithm presents a constraint for the implementation of a multiple scattering capability. In order to optimize computational efficiency and minimize online storage requirements, FASCODE program logic calculates path transmittance and radiance in a single unidirectional pass through the desired atmospheric path. This pass commences with the highest pressure sublayer (i.e., that requiring the least spectral resolution) and progresses monotonically to the lowest pressure sublayer requiring the highest spectral resolution. Cumulative quantities with spectral structure (such as transmittance and radiance) are evaluated by merging the lower resolution results from the previous layer with the higher resolution results of the current layer. While this procedure is appropriate for nonscattered radiance where the local source function for a layer consists solely of contributions from local thermal emission, the methodology is not valid in the presence of multiple scattering. Fundamentally, the local multiply-scattered (MS) source function is composed of contributions scattered from layers, both above and below the current layer in addition to local thermal emission. Therefore, a modification of the FASCODE program logic is required to incorporate the stream approximation (SA) for multiple scattering within FASCODE. The SA efficiently provides an estimate of the local multiply-scattered source function given the availability of a suitable estimate of the profiles of upward and downward flux. Evaluation of the flux profile, however, requires a priori total atmospheric properties such as optical depth and single scattering albedo profiles. This is not possible with the current layer by layer FASCODE algorithm. Once obtained, the source function for the multiply-scattered radiance may be summed along the desired path in analogy to the approach currently used within FASCODE to obtain the thermal emission via summation of the local Planck function contributions.

This apparent inconsistency of FASCODE with multiple scattering is resolved by combining the stream approximation approach with the adding method to obtain the required MS flux profiles. In the adding method, properties of individual layers (such as emission, transmission, and reflection) are

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combined algebraically to yield the overall properties of the combined layers. A typical application of the adding method consists of two opposite unidirectional passes throughout the atmosphere. In the FASCODE implementation, the existing upward pass is exploited to set up one part of the adding calculation. This is done subsequent to the existing calculation of optical depths via the combined line-by-line gas absorption and LOWTRAN-based aerosol extinction routines. The upward pass also provides an opportunity to evaluate and merge radiance contributions due to thermal emission only. A downward pass, unique to MS cases, completes the calculation. During the downward pass, actual fluxes will be calculated for each layer, layer multiply-scattered source function evaluated using the stream approximation, and multiply-scattered radiances summed along the desired path. These radiances will be merged with the nonscattered radiance contributions evaluated during the upward pass to yield total cumulative multiply-scattered radiance.

The combined stream approximation/adding method approach for FASCODE is summarized in the flow chart presented in Figure 3-1. The shaded areas denote modifications to FASCODE to accommodate multiple scattering. The unshaded code segment on the left-hand side of the diagram represents the existing non-MS FASCODE algorithm. Within the shaded portion during the upward pass are code modifications to calculate: (a) layer single scatter albedo,  $\omega_\Omega^{\ \ N}$ , and phase function asymmetry factor,  $g^{N}$ ; (b) layer reflection and transmission functions,  $R_N$ ,  $T_N$ , respectively and intrinsic upward and downward fluxes  $F_N^{\pm}$ using the two stream approximation; (c) beginning of the adding method for composite upward fluxes and reflection, 1F+, R+, respectively; and (d) layer and merged values of the thermal radiance contribution  ${\rm E_N}^{\rm o}$  based on the  ${\rm J_N}^{\rm o}$ source function described above. The downward pass completes the adding method. Details will be described in the following sections. Notably, the time-consuming line-by-line calculations are done once only during the upward pass. The downward pass is a simple merging of precalculated and stored quantities based on algebraic manipulations.



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Figure 3-1. FASCODE implementation of stream approximation/adding method.

### 3.1.2 Adding Method

To illustrate the application of the adding method to calculate the actual flux profiles, consider the layered atmosphere illustrated in Figure 3-2. There are four layers (N-1), (N), (N+1), and (N+2) above an emitting surface (N-2). As each layer is treated during the existing FASCODE upward pass, the following quantities are evaluated:

N+2	$T_{N+2}$ , $T_{N+2}$ , $F_{N+2}^{\pm}$
N+1	$R_{N+1}, T_{N+1}, F_{N+1}^{\pm}$
N	$R_N$ , $T_N$ , $F_N^{\pm}$
N-1	$R_{N-1}, T_{N-1}, F_{N-1}^{\pm}$
N-2	//////////////R <sub>N-2</sub> , F <sup>+</sup> <sub>N-2</sub>

Figure 3-2. Schematic of FASCODE model atmosphere layers.

$$au_{g}^{N}$$
 gas absorption optical depth via line-by-line  $au_{g,s}^{N}$  molecular scattering via LOWFAS  $au_{a,a}^{N}$  aerosol absorption optical depth via LOWFAS  $au_{a,s}^{N}$  aerosol scattering optical depth via LOWFAS  $au_{a,s}^{N}$  mean layer thermodynamic temperature via FASCODE layering.

For a multiple scattering (MS) calculation, the shaded branch of the upward path in Figure 3-1 is selected and the following two additional quantities are calculated:

$$\omega_0^N$$
 single scattering albedo =  $(\tau_{a,s}^N + \tau_{g,s}^N)/(\tau_g^N + \tau_{a,a}^N + \tau_{a,s}^N + \tau_{g,s}^N)$ 
 $g^N$  phase function asymmetry factor

The asymmetry factor is obtained from a look-up table for the appropriate aerosol model, wavenumber domain, and level.

The asymmetry factor is obtained from a look-up table for the appropriate aerosol model, wavenumber domain, and level.

Next, a simple two-stream approximation is used to evaluate the intrinsic layer fluxes,  ${\rm F_N}^\pm$ , transmission function (direct and diffuse),  ${\rm T_N}$ , and reflection function,  ${\rm R_N}_{\bullet}$ . The intrinsic layer fluxes,  ${\rm F_N}^\pm$  are the upward flux at the top and the downward flux from the bottom of the Nth isolated layer, respectively. These are analytical transformations of the form:

$$\{\tau_{g}^{N}, \tau_{a,a}^{N}, \tau_{a,s}^{N}, g^{N}, \theta^{N}\} \longrightarrow \{F_{N}^{+}, F_{N}^{-}, R_{N}, T_{N}\}. \tag{3.1}$$

Specific two stream flux formulations for solar and thermal scattering are given in Section 2.2.2. These are evaluated once during the upward pass through FASCODE at increasing spectral resolution with decreasing layer mean pressure, i.e.,  $\Delta\nu$  (N+1)  $<\Delta\nu$  (N) where N is layer index numbered consecutively from surface to space, and  $\Delta\nu$  is the spectral resolution for each layer determined by the FASCODE algorithm.

Surface emission is treated as the zeroth layer with:

$$F_{O}^{+} = \pi \epsilon_{S} B(\theta_{S})$$

$$R_{O} = (1 - \epsilon_{S})$$

$$F_{O}^{-}, T_{O} = 0$$
(3.2)

where  $\theta_s$  is the surface temperature and  $\epsilon_s$  is the surface emissivity. Likewise, a target at the top of the path may be treated as the Mth layer with:

$$F_{M}^{T} = \pi \varepsilon_{t} B(\theta_{t})$$

$$R_{M} = (1 - \varepsilon_{t})$$

$$F_{M}^{+}, T_{M} = 0$$
(3.3)

Similar considerations can be applied to treat nonscattering layers above and below the scattering layer system. As noted in the flow chart (Figure 3 1), an additional modification necessitated in order to accomplish a multiple scattering calculation is the consideration of bounding layers above an below the altitudes of the nodes of the specified path (i.e., H1 and H2). A minimum of one layer extending from the surface to H1 and from H2 to 15 km (assuming

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H2 < 15 km) is included. In order to illustrate application of the adding method, the required relations for the system illustrated in Figure 3-2 are presented explicitly. It has been assumed that multiple scattering contributions above 15 km will be negligible.

## 3.1.2.1 Upward Adding Pass

The loop begins by adding layer (N-1) to layer (N-2). Subsequent layers are added one at a time until layer (N+2) is reached. The modified upward flux from the combination of (N-2) and (N-1),  ${}^1F_N^+$ , consists of three contributions (see Figure 3-2):

- i. the intrinsic upward flux from layer (N-1),  $F_{N-1}^+$
- ii. the multiple reflection of the intrinsic upward flux from layer (N-2),  $F_{N-2}^+$ , transmitted through layer (N-1):

i.e., 
$$F_{N-2}^+ + T_{N-1}^- + F_{N-2}^+ T_{N-1}^- R_{N-1}^- R_{N-2}^- + F_{N-2}^+ T_{N-1}^- (R_{N-1}^- R_{N-2}^-)^2 + \dots$$

$$= F_{N-2}^+ T_{N-1}^- (1 - R_{N-1}^- R_{N-2}^-)^{-1}$$

iii. the multiple reflection of the intrinsic downward flux from layer (N-1),  $F_{N-1}^-$ , reflected from layer (N-2) and transmitted through layer (N-1):

i.e., 
$$F_{N-1}^- T_{N-1} R_{N-2}^- + F_{N-1}^- T_{N-1} R_{N-2}^- (R_{N-1} R_{N-2}^-) + \dots$$

$$= F_{N-1}^- T_{N-1} R_{N-2}^- (1 - R_{N-1} R_{N-2}^-)^{-1}$$

These will sum to the composite flux:

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$${}^{1}F_{N-1}^{+} = F_{N-1}^{+} + T_{N-1}(F_{N-2}^{+} + F_{N-1}^{-} R_{N-2})(1 - R_{N-1} R_{N-2})^{-1}$$
(3.4)

Similar considerations lead to the composite reflection of layers (N-1) and (N-2):

$$R_{N-1}^{+} = R_{N-1} + R_{N-2} T_{N-1}^{2} (1 - R_{N-1} R_{N-2})^{-1}$$
(3.5)

Next layer N is added to the composite of (N-1, N-2), resulting in composite values for layer N:

$${}^{1}F_{N}^{+} = F_{N}^{+} + T_{N}({}^{1}F_{N-1}^{+} + F_{N}^{-}R_{N-1}^{+})(1 - R_{N}R_{N-1}^{+})^{-1}$$
(3.6)

$$R_{N}^{+} = R_{N} + R_{N-1}^{+} T_{N}^{2} (1 - R_{N} R_{N-1}^{+})^{-1}$$
(3.7)

This process is repeated for layer (N+1):

$${}^{1}F_{N+1}^{+} = F_{N+1}^{+} + T_{N+1}({}^{1}F_{N}^{+} + F_{N+1}^{-} R_{N}^{+})(1 - R_{N+1} R_{N}^{+})^{-1}$$
(3.8)

$$R_{N+1}^{+} = R_{N+1} + R_{N}^{+} T_{N+1}^{2} (1 - R_{N+1} R_{N}^{+})^{-1}$$
(3.9)

and layer (N+2):

$${}^{1}F_{N+2}^{+} = F_{N+2}^{+} + T_{N+2}({}^{1}F_{N+1}^{+} + F_{N+2}^{-} R_{N+1}^{+})(1 - R_{N+2} R_{N+1}^{+})^{-1}$$
(3.10)

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$$R_{N+2}^{+} = R_{N+2} + R_{N+1}^{+} T_{N+2}^{2} (1 - R_{N+2} R_{N+1}^{+})^{-1}$$
(3.11)

Since there are no layers above (N+2), the upward composite  ${}^{1}F_{N+2}^{+}$  is identically the actual upward flux, i.e.,

$${}^{2}F_{N+2}^{+} = {}^{1}F_{N+2}^{+}$$
 (3.12)

Calculated composite layer values are required for the evaluation of the composite values of the subsequent layers. These intermediate quantities are merged to the next higher layer's spectral resolution and stored for subsequent use on the downward pass. At the termination of the upward pass, the following quantities have been calculated for each layer and stored for use during the downward pass: (a) the intrinsic layer values,  $\omega_0{}^N$ ,  $R_N$ ,  $T_N$ ,  $F_N$  (the intrinsic upward fluxes are not required), (b) the composite quantities,  ${}^1F_N^+$ ,  $R^+$ , and the nonscattered contribution to emission,  $E_N^0$ . These values are stored only at local layer resolution to minimize total memory requirements.

#### 3.1.2.2 Downward Pass

The downward pass is devoted exclusively to the adding method and stream approximation. No additional line-by-line calculations are performed. In analogy to its upward counterpart, downward composite fluxes,  ${}^1F_1$  and reflectance functions,  $R_N$ , are calculated during the unidirectional downward pass. However, in addition both actual upward and downward fluxes,  ${}^2F_N$ , are calculated from the composite fluxes and reflection functions.

For the topmost layer, no downward composite fluxes are possible (unless there are nonscattering layers above N+2). Therefore, the actual upward and downward fluxes at the interface of layers (N+1) and (N+2) are:

$${}^{2}F_{N+1}^{+} = ({}^{1}F_{N+1}^{+} + F_{N+2}^{-} R_{N+1}^{+})(1 - R_{N+2} R_{N+1}^{+})^{-1}$$
(3.13)

$${}^{2}F_{N+2}^{-} = ({}^{1}F_{N+2}^{-} + {}^{1}F_{N+1}^{+} R_{N+2})(1 - R_{N+2} R_{N+1}^{+})^{-1}$$
(3.14)

At this point, actual upward and downward fluxes are available at the boundaries of layer (N+2), facilitating calculation of the multiply-scattered source function,  $J_{N+2}^{MS}$ , using the stream approximation (see Equation (2.14)). This source function provides the layer contribution to multiply-scattered emission,  $E_{N+2}^{MS}$ . This is added to the thermal contribution  $E_{N+2}^{O}$  evaluated during the upward pass.

Proceeding downward, the composite quantities are first calculated by adding the next layer down to the composite above it, for example, the downward composite flux emerging from layer (N+1) and the corresponding downward composite reflection are:

$${}^{1}F_{N+1}^{-} = F_{N+1}^{-} + T_{N+1}(F_{N+2}^{-} + F_{N+1}^{+} R_{N+2})(1 - R_{N+2} R_{N+1})^{-1}$$
(3.15)

$$R_{N+1}^{-} = R_{N+1} + R_{N+2} T_{N+1}^{2} (1 - R_{N+1} R_{N+2})^{-1}$$
(3.16)

Actual fluxes at the interface of layers N and (N+1) are then obtained from the composite values:

$${}^{2}F_{N}^{+} = ({}^{1}F_{N}^{+} + {}^{1}F_{N+1}^{-} R_{N}^{+})(1 - R_{N}^{+} R_{N+1}^{-})^{-1}$$
(3.17)

$${}^{2}F_{N+1}^{-} = ({}^{1}F_{N+1}^{-} + {}^{1}F_{N}^{+} R_{N+1}^{-})(1 - R_{N}^{+} R_{N+1}^{-})^{-1}$$
(3.18)

For the next layer, N, the procedure is identical, resulting in the composites:

$${}^{1}F_{N}^{-} = F_{N}^{-} + T_{N}({}^{1}F_{N+1}^{-} + F_{N}^{+}R_{N+1}^{-})(1 - R_{N}R_{N+1}^{-})^{-1}$$
(3.19)

$$R_N^- = R_N^- + R_{N+1}^- T_N^2 (1 - R_N^- R_{N+1}^-)^{-1}$$
 (3.20)

and actual fluxes:

$${}^{2}F_{N-1}^{+} = ({}^{1}F_{N-1}^{+} + {}^{1}F_{N}^{-} R_{N-1}^{+})(1 - R_{N-1}^{+} R_{N}^{-})^{-1}$$
(3.21)

$${}^{2}F_{N}^{-} = ({}^{1}F_{N}^{-} + {}^{1}F_{N-1}^{+} R_{N}^{-})(1 - R_{N-1}^{+} R_{N}^{-})^{-1}$$
(3.22)

Finally, the procedure terminates at the surface layer (N-2), layer (N-1) interfaces where:

$${}^{1}F_{N-1}^{-} = F_{N-1}^{-} + T_{N-1}({}^{1}F_{N}^{-} + F_{N-1}^{+} R_{N}^{-})(1 - R_{N-1} R_{N}^{-})^{-1}$$
 (3.23)

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$$R_{N-1}^{-} = R_{N-1} + R_{N}^{-} T_{N-1}^{2} (1 - R_{N-1} R_{N}^{-})^{-1}$$
(3.24)

Then:

$${}^{2}F_{N-2}^{+} = (F_{N-2}^{+} + {}^{1}F_{N-1}^{-} R_{N-2})(1 - R_{N-2} R_{N-1}^{-})^{-1}$$
(3.25)

$${}^{2}F_{N-1}^{-} = ({}^{1}F_{N-1}^{-} + F_{N-2}^{+} R_{N-1}^{-})(1 - R_{N-2} R_{N-1}^{-})^{-1}$$
(3.26)

In this last step, the upward surface emission flux,  $F_{N-2}^+$ , and reflection function,  $R_{N-2}$ , are composite quantities since there are no layers below. This completes the downward pass and the multiply-scattered radiance calculation.

## 3.1.3 Stream Approximation, Source Function, Radiance

Using the stream approximation (SA), the multiply-scattered source function at optical depth,  $\tau$ , for a path with zenith angle,  $\cos^{-1} \mu$ , will be given by (see Equation (2.16)):

$$J_{SA}(\tau, \pm \mu) = [1 - \omega_{O}(\tau)]B(\theta) + \frac{\omega_{O}(\tau)}{\pi} \{F^{\pm}(\tau)[1 - \beta(\mu)] + F^{\mp}\beta(\mu)\}$$
 (3.27)

The plus sign is for downward looking paths ( $\mu$  > 0) while the minus sign is for upward looking paths ( $\mu$  < 0). In the expression above,  $\omega_0(\tau)$  is the single scattering albedo, B( $\theta$ ) is the Planck function, and  $\beta(\mu)$  is the backscatter fraction for path zenith angle  $\mu$ . The backscatter fraction is a function of the particulate asymmetry factor at level  $\tau$ , g( $\tau$ ), and is available from Wiscombe and Grams (1976).

For level N, the level source function is given by:

$$J_{N}^{SA}(\pm \mu) = (1 - \omega_{o}^{N}) B (\theta_{N}) + \frac{\omega_{o}^{N}}{\pi} \{ F_{N}^{\pm} [1 - \beta^{N}(\mu, g^{N})] + F_{N}^{\mp} \beta^{N}(\mu, g^{N}) \}$$
(3.28)

The first term above is due to nonscattered thermal emission, while the second term is due to multiple scattering. Thus, the source function can be written as:

$$J_{N}^{SA} = J_{N}^{o} (\omega_{O}^{N}, \theta_{N}) + J_{N}^{MS} (\mu, \omega_{O}^{N}, g^{N}, F_{N}^{\pm})$$
 (3.29)

where the thermal emission term  $J_N^{\ O}$  depends only on local layer properties, and the multiply-scattered term  $J_N^{\ MS}$  requires, in addition to local properties, the local fluxes which depend on the overall path properties. The first term is a generalization of the nonscattering thermal emission source function currently evaluated within FASCODE and may be treated in a like manner.

The path radiance or emission with multiple-scattering is obtained by summing radiance contributions along the path essentially as is currently done with no scattering. Along a path consisting of two layers, layer N and the layer above, N + 1, the emission depends on the path integral of the source function and is given by:

$$E_{N+1}^{+} = E_{N}^{+}T_{N+1} + J_{SA}^{N+1}(+\mu)(1 - T_{N+1})$$
 (3.30)

for downward looking and:

$$E_{N+1}^{-} = E_{N}^{-} + (1 - T_{N+1}) J_{SA}^{N+1} (-\mu) T_{N}$$
 (3.31)

for upward looking where:

$$E_N^{\pm} = (1 - T_N) J_{SA}^N(\pm \mu).$$
 (3.32)

With no scattering,  $\omega_0^{N, N+1} = 0$  and the source function for each layer reduces to the Planck function as in the original FASCODE, i.e.,:

$$\lim_{\omega_0 + 0} J_{SA}^{N} = B(\theta_N). \tag{3.33}$$

As described above, the thermal emission source  $J_N^O$  can be summed along the path in analogy to the current nonscattering radiance calculation to provide the path thermal emission  $E_N^O$ . Evaluation of the multiply-scattered radiance contribution  $E_N^{MS}$  for each layer is accomplished via the adding algorithm on the complementary downward pass where it is merged with the previously calculated nonscattered contributions to obtain total radiance.

## 3.1.4. Description of FASCODE2 with Multiple Scattering

In implementing multiple scattering into FASCODE2, the main considerations were in maintaining the integrity of the existing program, and in making the resultant code as transparent to the user as possible. The first and most constraining element of the existing code, was the use of panels in doing the radiance calculation. This necessitated that any multiple scattering implementation also be adjusted to utilize this methodology.

All of the routines to be listed below, utilize the existing FASCODE method of working with only a "panel" of numbers at a time. This necessitates a great deal of I/O for doing any calculation with multiple scattering, but allows for complete compatibility with the existing structure and execution of FASCODE. Another benefit of this approach, is that the program is compartmentalized, and the user should find no difference in run time for this program with multiple scattering turned off, and the previous version of FASCODE2.

As discussed above, flux adding, used in conjunction with the stream approximation was implemented as the best approach. This involved the extensive

modification of EMINIT, and RADMRG. These routines were modified to merge the composite fluxes and drive the flux-adding during the radiance calculation. The primary additions to the code, were the subroutines FLXADD, FLXDWN, and SRCFCN. FLXADD calculates and adds fluxes for each of the FASCODE layers. This routine is called within the layer loop from both EMINIT, and RADMRG. FLXDWN drives the downward flux adding, and is called from XLAYER after the FASCODE upward path is completed. SCRFCN evaluates the multiple scattered source function, and is called from FLXDWN.

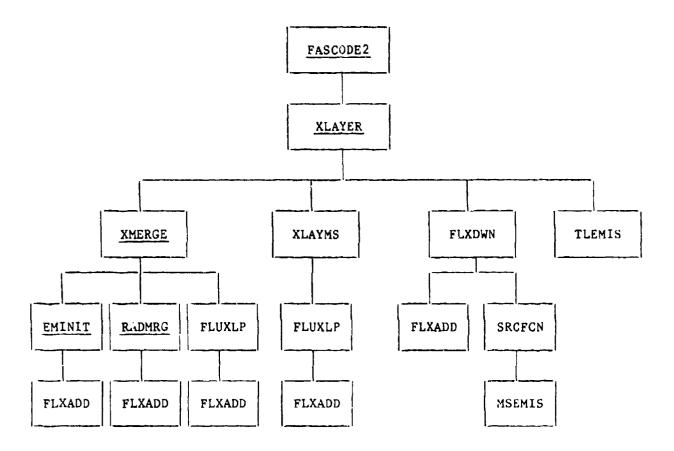
Several secondary routines that were added were MSEMIS, TLEMIS, XLAYMS, FLUXLP, MSIN, and MSOUT. MSEMIS merges the multiple scattered contribution to the radiance for each layer. TLEMIS merges the total multiple scattered radiance contribution obtained from MSEMIS and merges it with the total single scattered radiance calculated within FASCODE. XLAYMS drives the calculation of the radiance contribution from layers above the desired path. FLUXLP merges the fluxes and drives the flux-adding for layers in which radiances are not evaluated. The purpose of these last two routines will be discussed in Section 3.1.5. MSIN reads merged fluxes from the previous layer while MSOUT writes out the merged fluxes for the current layer.

Some minor additions were the functions BETABS, and E3. BETABS evaluates the backscattered fraction for a given angle and asymmetry factor. E3 evaluates the exponential integral E3(x). Some minor changes were also made to EMIN, GETEXT, AERF, EXTDTA, EXABIN, AEREXT, TRANS, LOWTRN, and ATMPTH. EMIN was modified to evaluate the thermal emission, for multiple scattering cases. GETEXT buffers in the asymmetry factors along with the extinction and scattering coefficients. AERF calculates the scattering optical thickness, and the asymmetry factor from the buffered in quantities. EXTDTA now contains the asymmetry factors for each of the LOWTRAN models. EXABIN does the level weighting for the asymmetry factors. AEREXT evaluates the asymmetry factors for each wavenumber. TRANS does the weighted average for the final asymmetry factor result. LOWTRN was modified to read in the asymmetry factors for user-defined aerosols. ATMPTH was modified to determine the multiple scattering path. This will be discussed in the next section.

A flowchart for FASCODE2 with multiple scattering is illustrated in Table 3-1. The structure of FASCODE2 with multiple scattering is outlined in Table 3-2 giving, also, brief descriptions of the altered and added routines. The segment load file and file usage are shown in Tables 3-3 and 3-4, respectively.

Table 3-1
Flowchart of FASCODE Multiple Scattering Routines

Underlined subroutines are modified from the existing FASCODE; others are new subroutines



#### Table 3-2

## Description and Segment Load Grouping of FASCODE2 Subroutines

(This listing will contain all the FASCODE routines but will only describe the routines pertinent to the multiple scattering calculation.)

```
FASCOD2*
                             Fast Atmospheric Signature Code
               /ADRIVE/
               /CONSTS/
               /FILHDR/
               /IFIL /
               /LANCHN/
               /LASIV /
               /MAIN /
               /MSACCT/*
                             Multiple Scattering files and parameters
               /MSCONS/*
                             Multiple Scattering flags and constants
               BUFIN
                BUFOUT
                COPYFL
                ENDFIL
                SKIPFL
  FLTRFN
                CNVFLT
                RDSCAN
  LASER
  PLTFAS
               /AXISXY/
               /NAME /
               /PLTHDR/
               /POINTS/
               /TITLOC/
               /YCOM /
                ENDPLT
                EXPT
                FSCLIN
                LINT
                MNMX
                TEMPFN
                TENLOG
                XNTLOG
```

THE STATE OF THE S

Legend: /Common Blocks/
(Block Data)
Subroutines

NOTE: "\*" designates routines added or modified in the implementation of Multiple Scattering by AER.

```
AXES
   AXISL
    AXLOG
   AX2
 BBSCLE
 FPLINE
 HEADER
SCANFN
             CKPRNT
             CNVREC
             CONVSC
             INTER
             PANLSC
             RDSCAN
             SHAPEG
             SHAPET
             SHRKSC
             SINCSQ
TEST
            (BTEST)
XLAYER*
                           Controls Layer by Layer Calculation
            /ABSORA/
            /ASYMMA/*
                           Aerosol Asymmetry Factors
            /LINHDR/
            /MLTSCT/*
                           General Labeled Common for Multiple Scattering
            /SCATTA/
             /RMRG /
            /XBLF
             MSCOPY*
                           Copies Multiple Scattering output files by panels
  FLXDWN*
                           Controls Layer by Layer Downward Flux Adding
             AERF*
                           Evaluates Extinction, Scattering, and Asymmetry
             BBFN
                           Computes Black Body Function
             E3*
                           Computes Exponential Integral E3
             FLXADD*
                           Calculates and does Adding of Fluxes for Current
                               Layer
             GETEXT*
                           Reads Extinction, Absorption, and Asymmetry
             MSIN*
                           Reads Merged Fluxes from Previous Layer
             MSOUT*
                           Writes Merged Fluxes for Current Layer
             RADFN
                           Computes Radiation Function
                           Evaluates Multiple Scattering Source Function
    SRCFCN*
                           and Radiance
              BETABS*
                           Calculates Back-Scattering Fraction
             MSEMIS*
                           Merges Multiple Scattered Radiance
```

```
OPDPTH
        /ABSORB/
        /SCATTR/
         /LBLF /
 CONTNM
         XINT
   FRNC02
   (BFCO2)
   FRN296
   (BFH20)
   N2CONT
   (BN2)
   O2CONT
   (02C)
   O3CHAP
    (03CH)
    ознито
    (ознно)
    O3HHT1
    (03HH1)
    03HHT2
    (ознн2)
    SL296
        (BS296)
    SL260
   (BS260)
  HIRAC1
         /FNSH /
         (BHIRAC)
         (BMOLEC)
         (BSHAPEL)
         (VOICON)
          ABSOUT
          CNVFNV
          MOLEC
          PANEL
          \mathbf{QV}
          RDLIN
          RIPRNT
          SHAPEG
          SHAPEL
          VERFN
          XINT
```

```
LBLF4
          (BMOLEC)
          (VOICON)
           CONVF4
           MOLEC
           QV
           RDLIN4
           SHRINK
 NONLTE
          /VBNLTE/
   HIRACQ
          /FNSQ
          (BHIRAQ)
          (BMOLEC)
          (BSHAPEL)
          (VOICON)
           ABSOUT
           CNVFNQ
           MOLEC
           PANELQ
           QV
           RDLIN
           RIPRNT
           SHAPEG
           SHAPEL
           VERFN
           XINT
 VIBPOP
 VIBIMP
OPPATH*
          /BNDRIES/
          /CNTRL
          /PATHD /
  FSCATM*
                         Obtains Refractive Path and Calculates Absorber
          /BNDRY /
          /CONSTN/
          /DEAMT /
          /HMULS /
          /PARMTR/
          /ZOUTP /
          (ATMCON)
           ATMPTH*
                         Atmospheric Path Driver
           PACK
           WATVAP
```

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```
FSCGEO
        ALAYER
        AMERGE
        ANDEX
        AUTLAY
        EXPINT
        FDBETA
        FINDSH
        FNDHNM
        HALFWD
        RADREF
        REDUCE
        RFPATH
        SCALHT
MDLATM*
                      Sets up selected Atmosphere
       /MDLATM/
       /TRAC /
       (MCATMB)
        CONVRT
        DEFALT
        NSMDL
        RDUNIT
LOWTRN*
                      LOWTRAN Driver for Acrosols
       /CNSTNS/
       /LCRD1 /
       /LCRD2 /
       /LCRD3 /
       /LCRD4 /
       /MART
       /MDLZ
       /MODEL /
       /RAIN /
       /TITL
       /USRDTA/
       /ZVSALY/
       (TITLE )
 AERNSM
        /MDATA /
       (MARDTA)
        (MDTA )
        (PRFDTA)
         AERPRF
         MARINE
         STDMDL
 CIRRUS
```

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	EXABIN*	Loads the Aerosol Extinction, Absorption and Asymmetry Coefficients for the desired Model
1111	/EXTD /*	Stores all the Aerosol Attenuation Coefficients
	(EXTDTA)*	Contains all the Aerosol Attenuation Coefficients
	AITK	
	DEBYE	
;	DOP	
1 1 1	GAMFOG GMRAIN	
111	INDX	
1111	GEO	
	/PARMLT/	
1 1 1	/RFRPTH/ ANDEX	
	EXPINT	
111	FDBETL	
	FILL	
	FINDSL	
	FNDHML GEOINL	
	LOLAYR	
	PACKL	
	RADREF	
1 1 1	REDUCL RFPATL	
	SCALHT	
	NEWMDL	
	TRANS*	Outputs Aerosol Optical Properties for Path
	AB AEREXT*	Interpolates Aerosol Attenuation Coefficients for
		values at Wavenumber v
	AITK DEBYE	
	DOP	
	GAMFOG	
	GMRAIN	
	INDX TNRAIN	
	11141111	
	VSA	
F	'ATH	
TLE	MIS*	Merges Multiple Scattered and Single Scattered
	EMOUT	Radiance for the Total Path Writes Merged Radiance and Transmittance Results

XLAYMS*		Contols Layer by Layer Calculation for Contributing Scattering Layers Above Desired Path
	AERF*	Evaluates Extinction, Scattering, and Asymmetry
} }	BBFN	Computes Black Body Function
Ì	EMIN*	Reads Optical Depths and Calculates Tgas
	E3*	Computes Exponential Integral E3
İİ	FLUXLP*	Merges Fluxes from Previous and Current Layer
	FLXADD*	Calculates and does Adding of Fluxes for Current Layer
11	GETEXT*	Reads Extinction, Absorption, and Asymmetry
1 1	MSIN*	Reads Merged Fluxes from Previous Layer
	MSOUT*	Writes Merged Fluxes for Current Layer
	RADFN	Computes Radiation Function
XMERGE*		Driver for Merging Options
	GETEXT*	Reads Extinction, Absorption, and Asymmetry
11	RADFN	Computes Radiation Function
{	XMERGI	Driver for Merging Routines using RADINT
ABINIT		Initializes Optical Depth Calculation
	ABSOUT	Writes Merged Optical Depth Results
ABSINT		Merges Optical Depths using General 4-point Interpolation
] ] ]	ABSOUT	Writes Merged Optical Depth Results
ABSMRG		Merges Optical Depths using Lagrange 4-point Interpolation
	ABSOUT	Writes Merged Optical Depth Results
ADARSL		Adds Absorption and Scattering to Common Blocks for use in a Transmittance Run
	AERF*	Evaluates Extinction, Scattering, and Asymmetry
{ { }	GETEXT*	Reads Extinction, Absorption, and Asymmetry
EMINIT*		Initializes Radiance Calculation with First Layer and Drives Layer Flux Calculation
	AERF*	Evaluates Extinction, Scattering, and Asymmetry
	BBFN	Computes Black Body Function
	EMIN*	Reads Optical Depths and Calculates Tgas
	EMOUT	Writes merged Radiance and Transmittance Results
	E3*	Computes Exponential Integral E3
	FLXADD*	Calculates and does Adding of Fluxes for Current Layer
	MSIN*	Reads Merged Fluxes from Previous Layer
	MSOUT*	Writes Merged Fluxes for Current Layer

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FLUXLP*	4 CD D+	Drives Layer Flux Calculation without Radiance
ķ	AERF*	Evaluates Extinction, Scattering, and Asymmetr
ļ	BBFN	Computes Black Body Function
	EMIN* E3*	Reads Optical Depths and Calculates τ <sub>gas</sub> Computes Exponential Integral E3
	FLXADD*	Calculates and does Adding of Fluxes for Curre
1	MSIN*	Reads Merged Fluxes from Previous Layer
	MSOUT*	Writes Merged Fluxes for Current Layer
RADINT		Merges Radiance and Transmittance using Genera 4-point Interpolation
}	AERF*	Evaluates Extinction, Scattering, and Asymmetr
[	BBFN	Computes Black Body Function
	EMBND	Evaluates Boundary Contribution to Radiance
i	EMIN*	Reads Optical Depths and Calculates τgas
1	EMOUT	Writes Merged Radiance and Transmittance Resul
RADMRG*		Merges Radiance and Transmittance using Lagrar 4-point Interpolation, and also Drives Lay Flux Calculation
1	AERF*	Evaluates Extinction, Scattering, and Asymmetr
1	BBFN	Computes Black Body Function
İ	EMIN*	Reads Optical Depths and Calculates Tages
1	EMOUT	Reads Optical Depths and Calculates τ <sub>gas</sub> Writes merged Radiance and Transmittance Resul
	E3*	Computes Exponential Integral E3
	FLXADD*	Calculates and does Adding of Fluxes for Curre
1	MSIN*	Reads Merged Fluxes from Previous Layer
1	MSOUT*	Writes Merged Fluxes for Current Layer

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# Table 3-3 Segment Load File for FASCODE2 with Multiple Scattering

```
FASCODE TREE
                     FASCOD2-(LAYRS, LASER, SCANFN, PLOTT,
,FLTRFN,TEST)
FASCOD2 GLOBAL
                     CONSTS, FILHDR, MAIN, IFIL, LAMCHN, LASIV, ADRIVE,
, MSACCT, MSCONS
FASCOD2 INCLUDE
                     FASCOD2, BUFIN, BUFOUT
LAYRS
          TREE
                     XLAYER-(OPPATHS, OPDPTHS, XMERGES, FLUXES, TLEMIS, XLAYMS)
XLAYER
          GLOBAL
                     LINHDR, XBLF, ABSORA, SCATTA, ASYMMA, RMRG, MLTSCT
          INCLUDE
XLAYER
                     XLAYER, MSCOPY
OPPATHS TREE
                     OPPATH-(FSCATMA, LOWT, PATH)
OPPATH
          GLOBAL
                     CNTRL, BNDRIES, PATHD-SAVE
OPPATH
          INCLUDE
                     OPPATH
FSCATMA TREE
                     FSCATM~(FSCGEO.MDLATM)
FSCATM
          INCLUDE
                     FSCATM, ATMPTH, ATMCON, PACK, WATVAP
FSCATM
          GLOBAL
                     CONSTN, HMOLS, PARMTR, DEAMT, ZOUTP, BNDRY-SAVE
                     RFPATH, ALAYER, AUTLAY, EXPINT, FINDSH, SCALHT, ANDEX,
FSCGE0
          INCLUDE
, RADREF, HALFWD, FSCGEO, FDBETA, FNDHMN, REDUCE, AMERGE
MDLATM
          INCLUDE
                     MDLATM, NSMDL, MLATMB, CONVRT, RDUNIT, DEFALT
MDLATM
          GLOBAL
                     MLATM, TRAC-SAVE
FLUXES
          TREE
                     FLXDWN-(SRCFCN)
FLXDWN
          INCLUDE
                     FLXDWN, RADFN, GETEXT, FLXADD, MSIN, MSOUT, E3, AERF, BBFN
LOWT
          TREE
                     LOWTRN-(GEO, EXABIN, TRANS, AERNS, VSA, CIRRUS, NEWMOL)
LOWTRN
          INCLUDE
                     TITLE
LOWTRN
          GLOBAL
                     LCRD1, LCRD2, LCRD3, LCRD4, MODEL, CNSTNS,
, MDLZ, ZVSALY, MART, USRDTA, TITL, RAIN-SAVE
          INCLUDE
                     GEO, GEOINL, REDUCL, EXPINT, RADREF, SCALHT, ANDEX,
, RFPATL, FDBETL, FNDHML, FINDSL, FILL, LOLAYR, PACKL
GEO
          GLOBAL
                     PARMLT, RFRPTH-SAVE
EXABIN
          INCLUDE
                     EXABIN, EXTUTA, INDX, DEBYE, DOP, AB, CAMFOG,
,AITK,GMRAIN
EXABIN
          GLOBAL
TRANS
          INCLUDE
                     TRANS, AEREXT, TNRAIN, DEBYE, DOP, INDX, AB,
,GAMFOG,AITK,GMRAIN
AERNS
          TREE
AERNSM
          INCLUDE
                     AERNSM, AERPRF, PRFDTA, MARINE, MARDTA, STDMDL, MDTA
          GLOBAL
AERNSM
                     MDATA-SAVE
PATH
          INCLUDE
                     PATH
XMERGES TREE
                     XMERGE-(ABINIT, ABSMRG, ABSINT, EMINIT, RADMRG, RADINT,
,ADARSL,FLUXLP)
XMERGE
          INCLUDE
                     RADFN, XMERGE, GETEXT, XMERGI
ADARSL
          INCLUDE
                     ADARSL, GETEXT, AERF
```

```
OPDPTHS
          TREE
                     OPDPTH-(HIRAC1, LBLF4, CONTNW, NLTE)
OPDPTH
          GLOBAL
                     LBLF, ABSORB, SCATTR
*
HIRACL
          INCLUDE
                     HIRAC1, SHAPEL, SHAPEG, VOICON, RDLIN, CNVFNV, PANEL, MOLEC,
,QV,ABSOUT, VERFN, RIPRNI, XINT, BMOLEC, BHIRAC, BSHAPEL
HIRACL
          GLOBAL
                     FNSH-SAVE
LBLF4
                     LBLF4, RDLIN4, CONVF4, MOLEC, QV, SHRINK, VOICON, BMOLEC
          INCLUDE
                     CONTNM-(SL296, SL260, FRN296, FRNCO2,
CONTNW
          TREE
N2CONT, O3CHAP, O3HHTO, O3HHT1, O3HHT2, O2CONT)
          INCLUDE
                     CONTNM, XINT
CONTNM
03CHAP
          INCLUDE
                     O3CHAP, O3CH
03HHT0
          INCLUDE
                     ознито, ознио
O3HHT1
          INCLUDE
                     03HHT1,03HH1
          INCLUDE
                     03HHT2,03HH2
03HHT2
02CONT
          INCLUDE
                     O2CONT,O2C
SL296
          INCLUDE
                     SL296, BS296
SL260
          INCLUDE
                     SL260, BS260
                     FRN296, BFH20
FRN296
          INCLUDE
FRNC02
          INCLUDE
                     FRNCO2, BFCO2
N2CONT
          INCLUDE
                     N2CONT, BN2
NLTE
          TREE
                      NONLTE-(HIRACQ, VIBTMP, VIBPOP)
NONLTE
          GLOBAL
                      VBNLTE
                      HIRACQ, SHAPEL, SHAPEG, VOICON, RDLIN, CNVFNQ, PANELQ,
HIRACQ
          INCLUDE
, MOLEC, QV, ABSOUT, VERFN, RIPRNT, XINT, BMOLEC, BHIRAQ, BSHAPEL
HIRACQ
          GLOBAL
                      FNSQ-SAVE
          INCLUDE
                      ABINIT, ABSOUT
ABINIT
ABSMRG
          INCLUDE
                      ABSMRG, ABSOUT
          INCLUDE
                      ABSINT, ABSOUT
ABSINT
          INCLUDE
                      EMINIT, EMIN, EMOUT, MSIN, MSOUT, BBFN, AERF, FLXADD, E3
EMINIT
                      RADMRG, EMIN, EMOUT, MSIN, MSOUT, BBFN, AERF, FLXADD, E3
RADMRG
           INCLUDE
RADINT
           INCLUDE
                      RADINT, EMIN, EMOUT, BBFN, AERF, EMBND
SRCFCN
           INCLUDE
                      SRCFCN, BETABS, MSEMIS
TLEMIS
           INCLUDE
                      TLEMIS, EMOUT
                      XLAYMS, GETEXT, RADFN, FLUXLP, MSIN, MSOUT, EMIN, EMOUT,
XLAYMS
           INCLUDE
 ,FLXADD,BBFN,AERF,E3
                      FLUXLP, FLXADD, MSIN, MSOUT, BBFN, AERF, EMIN, E3
FLUXLP
           INCLUDE
                      SCANFN, SHAPEG, RDSCAN, SHRKSC, SHAPET, CONVSC, PANLSC,
SCANFN
           INCLUDE
 , CNVREC, SINCSQ, CKPRNT, INTER
```

Table 3-3 (Cont.)

The Control of the Co

•		
FLTRFN *	INCLUDE	FLTRFN, RDSCAN, CNVFLT
TEST *	INCLUDE	TEST, BTEST
PLOTT	TREE	PLTFAS-(BBSCLE, HEADER, AXEST, FPLINE)
PLTFAS	GLOBAL	PLTHDR, AXISXY, YCOM, POINTS, TITLOC, NAME
PLTFAS ,ENDPLT	INCLUDE	PLTFAS, LINT, EXPT, XNTLOG, TEMPFN, TENLOG, MNMX, FSCLIN,
*		
AXEST	TREE	AXES-(AXISL, AXLOG, AX2)
	END	FASCOD2

## Table 3-4 File Usage

### UNIT NAMES:

- TAPE5 INPUT TAPE6 - OUTPUT
- TAPE10 Output file containing gas optical depths for current layer.
  Labeled KFILE.
- TAPEll Output file. For FASCODE runs without MS, it contains merged results from previous layer. For multiple scattering runs, it contains the merged total radiance and transmittance for the path. Label alternates between LFILE and MFILE. Always labeled LFILE for final output.
- TAPE12 Output file. For FASCODE runs without MS, it contains the final merged results. For multiple scattering runs, this file contains the total thermal emission radiance. Label alternates between MFILE and LFILE. Always labeled MFILE for final output.
- TAPE19 Intermediate output file, containing aerosol coefficients for path above desired path. Only used if upper path is defined. Labeled IMSFIL.
- TAPE20 Intermediate output file, containing aerosol coefficients for desired path. Labeled IEXFIL.
- TAPE21 Intermediate output file, containing total layer flux values.

  Label alternates between ISFILE and LSFILE.
- TAPE22 Intermediate output file, containing composite layer flux values. Label alternates between JSFILE, KSFILE, and MSFILE.
- TAPE23 Intermediate output file, containing composite layer flux values. Label alternates between JSFILE, KSFILE, and MSFILE.
- TAPE24 Intermediate output file, containing total layer flux values.

  Label alternates between ISFILE and LSFILE.

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- TAPE25 Intermediate output file, containing composite layer flux values. Label alternates between JSFILE, KSFILE, and MSFILE.
- TAPE26 Intermediate output file. This file holds optical properties for upper path for the upward adding loop, and for the downward loop it contains the final multiple scattered contribution to the radiance for the FASCODE path. Initially labeled IEFILE, labeled KEFILE at end of run.
- TAPE27 Intermediate output file, containing the multiple scattered contribution to the radiance. Label alternates between IEFILE, JEFILE, and KEFILE.
- TAPE28 Intermediate output file, containing the multiple scattered contribution to the radiance. Label alternates between IEFILE, JEFILE, and KEFILE.

Note: TAPE10 - TAPE28 are in buffered binary format.

### UNIT NAMES

- KFILE Contains gas optical depths for current layer.
- LFILE Contains results of previous layer for FASCODE runs without multiple scattering. Contains final merged results for multiple scattering run.
- MFILE Contains final merged results for FASCODE runs without multiple scattering. Contains total single scattered results for multiple scattering runs.
- IMSFIL Contains aerosol coefficients for path above desired path.
- IEXFIL Contains aerosol coefficients for desired path.
- ISFILE Contains total composite fluxes for previous layer.
- JSFILE Contains downward composite fluxes for current layer.
- KSFILE Contains upward composite fluxes for previous layers during upward adding loop. Contains downward composite fluxes for previous layer during downward adding loop.
- LSFILE Contains total composite fluxes for current layer.
- MSFILE Contains upward composite fluxes for current layer during upward adding loop. Contains upward composite fluxes for all layers during downward adding loop.
- IEFILE Contains Tgas for upper path during upward adding loop. Contains multiple scattering contribution to the radiance from the current layer during downward adding loop.
- JEFILE Contains multiple scattering contribution to the radiance from the previous layers.
- KEFILE Contains total multiple scattering contribution to the path radiance.

### 3.1.5 Notes on the Operation of FASCODE2 with Multiple Scattering

In order to use FASCODE2 with multiple scattering, it would be helpful to understand a little about how and why it does the calculation the way it does. Supplemental user instructions are listed in Table 3-5. The first thing that the user will note, is that a new flag appears in Card 1.2. This flag is for turning off and on the multiple scattering sections of the program. As outlined in the user instructions, various other parameters must also be set so that a) aerosols are included, b) radiance is calculated, c) FSCATM is called, and d) normal merging is done.

The next card, is where an understanding of how the calculation is performed can be very useful. Card 1.2a is a new card which is only read if IMS=1. This card includes four quantities, a) TGRND, which is the temperature of the ground (at 0.0 km), b) SEMIS, which is the emissivity of the surface

(at 0.0 km), c) HMINMS, the minimum height for multiple scattering (default = 0.0 km), and d) HMAXMS, the maximum height for multiple scattering (default = 15.0 km). HMINMS and HMAXMS determine the bounds that are placed on the multiple scattering calculation. HMINMS determines the height at which multiple scattering will start. HMAXMS determines the height above which multiple scattering paths are not calculated. If the maximum of the desired path is below HMAXMS, the program will define a path from the maximum of the desired path to HMAXMS. If the maximum of the desired path is above HMAXMS, then HMAXMS is ignored, but the entire path is calculated using multiple scattering. This means that HMAXMS only checks to see if the contribution from above should be added, but does not cut off the multiple scattering calculation at that height. For the case where the minimum of the desired path is above HMAXMS, then no multiple scattering is performed for that path.

For example, if the user defined a slant path from 4.0 to 10.0 km, with HMINMS = 0.0 km and HMAXMS = 15.0 km, the program would first define a new path from 10.0 to 15.0 km, to obtain the downward flux contribution. Secondly, a path from 0.0 to 4.0 km would be defined to obtain the contribution from the layers below 4 km. Then lastly the program would define the path from 4.0 to 10.0 km and calculate the desired radiances, adding in any contributions obtained from the first two calculations. It should therefore be clear that a simple path from 4.0 to 10.0 km using multiple scattering, may actually involve the execution of FASCODE for THREE separate paths. This therefore can increase the run time proportionally.

This example just described, is the worst case scenario. Another case could consider a path from 10 to 30 km, with HMINMS and HMAXMS as before. The program would first define a path from 0.0 to 10.0 km to obtain the contribution from below, and would then do the path from 10 to 30 km using multiple scattering. Yet another possibility, is to define a path from 0.0 to 10.0 km, with HMINMS and HMAXMS as before. The program would first do a path from 10 to 15 km to obtain the contribution from above, and then do the path from 0.0 to 10.0 km. The final possible case, is to define a path from 0.0 to 20.0 km with HMINMS and HMAXMS still set to 0.0 and 15.0 km respectively. This would result in only one path from 0.0 to 20.0 km calculating the multiply scattered radiances.

One thing the user should note, is that in the preceding examples there was no mention of angles, or tangent paths. That is because this methodology is true without regard to the angle for slant paths, and is true for all tangent paths. For example, if you want to consider a tangent path starting at 25 km with a minimum at 10 km, and a range of 1000 km, leaving HMINMS and HMAXMS as previously defined. The program would first do the slant path from 0.0 to 10 km to obtain the contribution from below, and would then do the desired tangent path.

The following items should be noted by the user:

- When doing a multiple scattering run, the input file is rewound so it is not possible to string multiple scattering jobs together.
- 2) Additional paths which are defined by the multiple scattering parameters will increase run time proportionaly.
- 3) Some coding notes:
  - a) The coding which sets and determines the multiple scattering paths is contained in ATMPTH.
  - b) The two routines, XLAYMS & FLUXLP were written for the multiple scattering paths which don't require the calculation of radiances.

A test case for FASCODE along with the input and output files is described in Appendix B.

#### Table 3-5

# Supplemental User Instructions for Using FASCODE2 with Multiple Scattering

The following user instruction cards are not a complete FASCODE2 user deck, but only present the changes to existing cards and/or the addition of new cards required for Multiple Scattering runs.

1) CARD 1.2 now appears as follows:

```
IHIRAC, ILBLF4, ICNTNM, IAERSL, IEMIT, ISCAN, IFILTR, IPLOT,
                           20,
                                  25,
                   15,
                                         30,
                                                 35,
 4X,11, 4X,11, 4X,11, 4X,11, 4X,11, 4X,11, 4X,11, 4X,11,
                        ILAS,
                                              MPTS,
 ITEST.
         IATM.
                 IMRG,
                                 IMS, IRAD,
                   55,
                                             71-75, 76-80
                           60,
                                  65,
                                        70,
        4X,I1,
                4X,Il,
                        4X,11, 4X,11, 4X,11,
 4X,I1,
                                                 15,
```

where each of the parameters is as defined in the FASCODE2 user instructions, excluding the new flag, IMS which is used for turning on the multiple scattering sections of FASCODE2.

- IMS (0,1) flag for multiple scattering
  - = 0 normal FASCODE run, no scattering
  - = 1 FASCODE run with multiple scattering

NOTE: the following must also be true for multiple scattering:

- a) IAERSL = 1 or 7
- b) IEMIT = 1

- c) IATM = 1
- d) IMRG = 0
- 2) CARD 1.2a (this card directly follows Card 1.2)

\*\*\*\* Required if IMS = 1, otherwise omit.

TGRND, SEMIS, HMINMS, HMAXMS

1-10, 11-20, 21-30, 31-40

E10.3, E10.3, E10.3, E10.3

TGRND Temperature of surface (degrees Kelvin)

(no default value)

SEMIS Emissivity of surface

(no default value)

HMINMS Minimum height for Multiple Scattering

(default = 0.0 km)

HMAXMS Maximum height for Multiple Scattering

(default = 15.0 km)

3) CARD 3.6 (optional card for LOWTRN subroutine) now appears as follows:

(1 to 16) (DUMMY, EXTC(1,1), ABSC(1,1), ASYM(1,1), (1=1,47))

Format (3(F6.2, 2F7.5, F6.4))

where EXTC, and ABSC are as defined in FASCODE2 user instructions, and ASYM is the Aerosol Asymmetry Factor which is required for multiple scattering calculations.

NOTE: When multiple scattering runs are performed, subsequent runs cannot be done using only one input deck. This is due to the rewinding of the input deck during multiple scattering execution. It is therefore required that each multiple scattering run, necessitates its own input deck.

### 3.2 LOWTRAN Implementation

### 3.2.1 Overview

In this section, we describe the technical details of incorporating into LOWTRAN 6 the multiple scattering treatment together with the k-distribution method. The procedure and the new code structure are also presented. The existing LOWTRAN 6 program structure is shown in Figure 3-3 (Figure 27 of Kneizys et al., 1983). For simplicity of implementation, we have added only two new subroutines, MSRAD and FLXADD, to handle the k-distribution and multiple scattering. The subroutine FLXADD is called from MSRAD. The functions of MSRAD and FLXADD are shown in Figure 3-4, while the individual elements are described below.

### 3.2.2 k-Distribution Method

Because of the complicated molecular absorption band structure of the gases, a rigorous frequency integration would require a line-by-line integration which clearly is very time consuming and thus not acceptable for LOWTRAN. Our approach to this problem is the application of the absorption coefficient (k) distribution method (cf. Wang and Ryan, 1983; Stephens, 1984). In a homogeneous gas  $1_{\cdot\cdot}$  er, the k-distribution function is formally related to the mean transmission function  $T_{\Lambda_{11}}(u)$ ,

$$T_{\Delta \nu}(u) = \frac{1}{\Delta \nu} \int_{\Delta \nu} e^{-ku} d\nu = \int_{0}^{\infty} f(k)e^{-ku}dk$$

$$= \int_{0}^{1} e^{-ku}dg = \int_{1-1}^{n} e^{-k}i^{u} \Delta g_{1}$$
(3.34)

where  $\Delta v$  is the narrow repeated interval (20 cm<sup>-1</sup> in LOWTRAN) and u is the gas amount. The f(k) for a given gas at a specified  $\Delta v$  is the probability density function such that f(k)dk is the fraction of the frequency interval for which the absorption coefficient is between k and k + dk. Eqn. (3.34) reveals that the transmission depends on the distribution of k-values within  $\Delta v$  but not on the ordering of the values. The cumulative k-distribution function is g(k), while  $(k_i, \Delta g_i)$  are the discreet sets of values to approximate the integral.

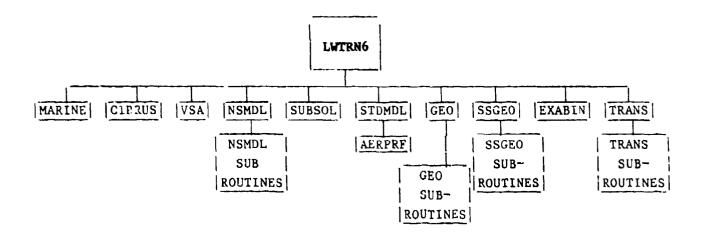
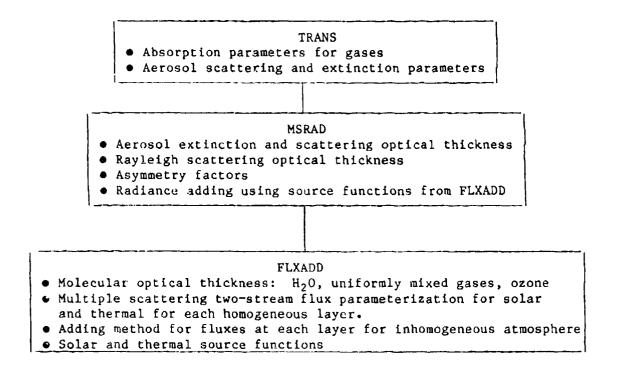


Figure 3-3. LOWTRAN 6 Main Program Structure



■ ことというないできないのではは、ことととないとは、ことできないできないできない。このではなる。ないできないできない。これできないできない。 では、こととのできないできないできないというとは、ことできないできないできないできないできない。このでは、ことできないできない。これできないできないできないできない。

Figure 3-4. Functions of subroutine TRANS, MSRAD, and FLXADD used in the LOWTRAN implementation of multiple scattering.

For the lummation in Eq. (3.34) to be useful with LOWTRAN, values for k and  $\Delta g$  must be found to fit the LOWTRAN transmission data for water vapor/uniformly mixed gases ( $H_2O^+$ ) and ozone ( $O_3$ ). The transmission for water vapor/uniformly mixed gases and ozone may be expressed as

$$T_1 = T(H_2O^+) = \sum_{i=1}^{M} e^{-k_i u_i} \Delta g_i$$
 (3.35)

$$T_2 = T(O_3) = \sum_{j=1}^{N} e^{-k_j u_2} \Delta g_j.$$
 (3.36)

The problem of fitting LOWTRAN transmission data as an exponential sum has been handled successfully by Wiscombe and Evans (cf. Wiscombe and Evans, 1977), using 10 k and  $\Delta g$  values for  $H_2O^+$  and six for  $O_3$ . Their k values and associated  $\Delta g$  values are listed in Table 3-6. Plots of the percent transmission error of their fit relative to the LOWTRAN data for both  $H_2O^+$  and  $O_3$  as a function of log10 of the effective optical depth are shown in Figures 3-5 and 3-6.

Making use of the Wiscombe and Evans exponential sum fit of the LOWTRAN transmission data yields values of  $k_i$ ,  $k_j$ , and  $\Delta g_i$ ,  $\Delta g_j$  for M = 10, N = 6. However, if M  $\neq$  N and  $\Delta g_i \neq \Delta g_j$ , it is necessary to perform multiple scattering calculations separately for water vapor/uniformly mixed gases ( $H_2O^+$ ) and ozone ( $O_3$ ) using two probability (k) loops. This problem is avoided by choosing either the 10  $H_2O^+$  or 6  $O_3$   $\Delta g_i$  values and then expressing the transmission of both  $H_2O^+$  and  $O_3$  as the sum of either 10 or 6 terms. Run time efficiency concerns suggest that both transmissions be expressed as the sum of six exponentials, using the  $\Delta g_i$  values for the ozone fit shown in Table 3-6. Thus, in the LOWTRAN implementation, the transmission function for water vapor is refit to the  $\Delta g$  values for ozone for each path. The transmission as a function of probability is shown in Figure 3-7. (Figure is illustrative only — actual values are not plotted.)

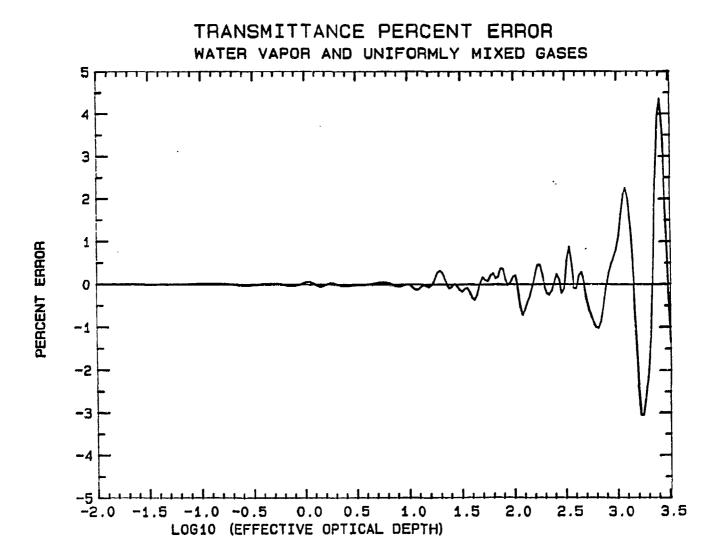


Fig. 3-5 Percent error of transmittance fit for water vapor and uniformly mixed gases relative to LOWTRAN values. Transmittance fit is based on Wiscombe and Evans, 1977

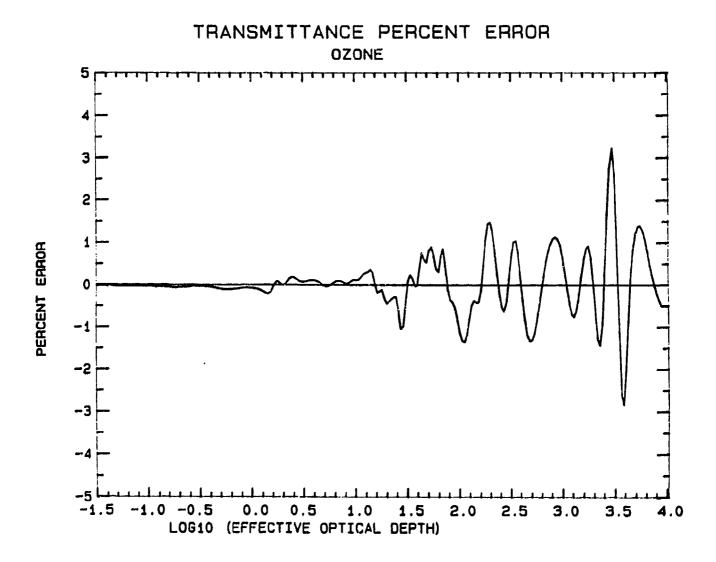
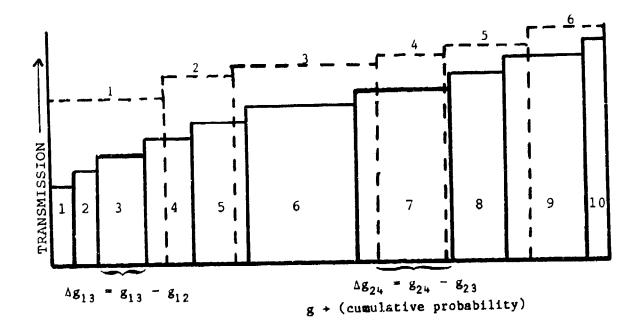


Fig. 3-6 Percent error transmittance fit for ozone relative to LOWTRAN values. Transmittance fit is based on Wiscombe and Evans, 1977.



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 $H_20^+$ ----  $O_3$   $g_{1i} = cumulative probability for <math>H_20^+$   $g_{2j} = cumulative probability for <math>O_3$ 

Legend

Figure 3-7. Transmission vs. cumulative probability for Wiscombe and Evans (1977) fit to LOWTRAN  $\rm H_2O^+$  and  $\rm O_3$  transmission values. (Figure does not depict actual transmission values.)

As an example, the refit  ${\rm H_2O}^+$  transmission for the first of six components may be expressed as

$$T_{11}^{\prime} = \left[T_{11} \Delta g_{11} + T_{12} \Delta g_{12} + T_{13} \Delta g_{13} + T_{14}(g_{21} - g_{13})\right] / \Delta g_{21}, \tag{3.37}$$

where  $T_{1i} = e^{-k_1 u_1}$ , i = 1, 10, so that  $T(H2O^+) = T1 = \int_{i=1}^{6} T_{1i}^i \Delta g_i$ . The total molecular transmission for  $H_2O^+$  and  $O_3$  for a particular layer for some small frequency interval is now

$$T_1 \cdot T_2 = \begin{bmatrix} \frac{6}{1} e^{-k_1^2 u_1} \Delta g_1 \end{bmatrix} \cdot \begin{bmatrix} \frac{6}{1} e^{-k_1^2 u_2} \Delta g_1 \end{bmatrix}.$$
 (3.38)

Assuming no overlap of gas absorption, the many cross terms may be eliminated, resulting in

$$T_1 \cdot T_2 = \sum_{i=1}^{6} e^{-(k_i^2 u_1 + k_i u_2)} \Delta g_i.$$
 (3.39)

Figure 3-8 compares the product of the water vapor and ozone obtained from: (1) the intrinsic LOWTRAN band model, (2) the k-distribution fit including overlap terms (Eqn. (3.38)), and (3) the k-distribution fit assuming no overlap terms (Eqn. (3.39)), i.e., eliminating cross terms. This calculation is for the near surface layer of a US standard atmosphere run and covers the spectral range from about 6.7 to 20  $\mu$ m. It can be seen that there is some difference between the calculated transmission but very little of practical consequence for the multiple scattering calculation.

The individual components of the combined gas  $({\rm H}_20^+ + {\rm O}_3)$  molecular absorption transmission can thus be expressed by

$$T_i = T_{1i}^t \cdot T_{2i}, \quad i = 1, 2, \dots 6.$$
 (3.40)

The jth component of the optical thickness of a given layer due to molecular absorption is

$$\tau_{\rm u} = -\ln (T_{\rm j}).$$
 (3.41)

 $T_{\rm j}$  is added to the molecular continuum, aerosol extinction, and molecular scattering optical thickness to determine the total optical thickness for each k value and layer in FLXADD.

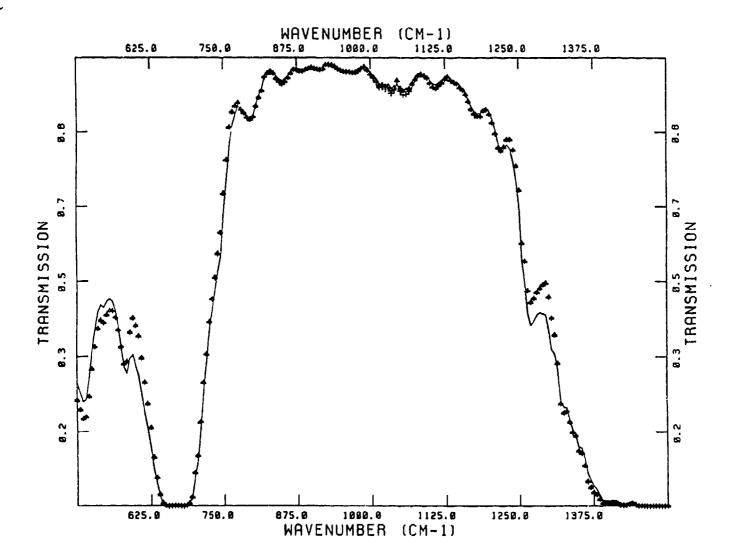


Fig. 3-8. Comparison of LOWTRAN transmission (line) to that calculated from the k-distribution model assuming no overlap (+) and including overlap ( $\Delta$ ).

It is important to note that the k-distribution transmittances are employed only in the determination of the multiply scattered source function. The adding of radiances based on the source function depends on the original LOWTRAN transmissions. Thus, errors in the combined k-distribution/stream approximation approach for multiple scattering are not propagated beyond the approximate multiple scattering approach.

Table 3-6

The Set of k<sub>i</sub> and Ag<sub>i</sub> Values Used to Approximate the LOWTRAN 6 Transmission Data

i	k <sub>i</sub>	Δg <sub>i</sub>
I. Water Vapor	Uniformly Mixed Gases	
1	$1.718754 \times 10^{-2}$	1.233690 x 10 <sup>-4</sup>
2	$2.490766 \times 10^{-1}$	$4.614758 \times 10^{-3}$
3	2.328222	$2.404693 \times 10^{-2}$
4	$7.744676 \times 10^{-1}$	$2.772890 \times 10^{-2}$
5	$2.229876 \times 10^{-1}$	$5.409872 \times 10^{-2}$
6	$4.438688 \times 10^{-2}$	2.119191 x 10 <sup>-1</sup>
7	$1.081388 \times 10^{-2}$	2.776904 x 10 <sup>-1</sup>
8	$3.054533 \times 10^{-3}$	$3.089278 \times 10^{-1}$
9	$1.258653 \times 10^{-3}$	$9.072606 \times 10^{-2}$
10	0.000000	1.240893 x 10 <sup>-4</sup>
I. Ozone		
1	$4.736517 \times 10^{-1}$	7.395116 x 10 <sup>-2</sup>
2	$3.823806 \times 10^{-2}$	$5.557539 \times 10^{-1}$
3	$7.424869 \times 10^{-3}$	$2.476504 \times 10^{-1}$
4	$1.785435 \times 10^{-3}$	$8.688930 \times 10^{-2}$
5	$4.336295 \times 10^{-4}$	$3.565867 \times 10^{-2}$
6	0.000000	$1.385517 \times 10^{-4}$

### 3.2.3 Inhomogeneous Atmosphere

For inhomogeneous atmospheres, we adopt the same scaling approximation used in LOWTRAN (see Eqn. 2.21):

$$k_{i}(P,0) = k_{i}(P_{0},0_{0}) \frac{P}{P_{0}} \sqrt{0_{0}/0}$$

We use the same adding method discussed in Section 3.1.2 to calculate the thermal radiation flux in an inhomogeneous atmosphere. Basically, the parameters used are  $F^+$ ,  $F^-$ , T, and R, as presented in Section 3.1.2.

### 3.2.4 Stream Approximation, Source Function, and Radiance Calculation

Again, we use the same procedures discussed in Section 3.1.3. to calculate the radiance from the source function and stream approximation.

The multiple scattered contribution to the source function is approximated by (Eqn. 2.14, 2.2, 2.3, 2.10, 2.11).

$$J_{MS}(\tau, \pm \mu, \phi) \simeq \frac{\omega_{O}(\tau)}{\pi} \left\{ F^{\pm}(\tau) [1 - \beta(\mu)] + F^{\mp}(\tau) \beta(\mu) \right\}. \tag{2.14}$$

The total source function is:

$$J(\tau,\mu,\phi) = J_0(\tau,\mu,\phi) + J_{MS}(\tau,\mu,\phi)$$
 (2.2)

where:

$$J_{O}(\tau,\mu,\phi) = \frac{\omega_{O}(\tau)}{4\pi} \pi F e^{-\tau/\mu_{O}} P(\Omega;-\Omega_{O}) + \left[1-\omega_{O}(\tau)\right] B[\Theta(\tau)]$$
(2.3)

The single scattered contribution to  $J_{\rm O}$  above is taken directly from the existing LOWTRAN single scattering coding. (Actually the summed multiply scattered radiance is added to the summed singly scattered radiance.)

One essential difference between the multiple scattering radiance implementation and the previous single scattering version is the treatment of surface reflection. Through the surface boundary condition, surface reflection affects the flux profile and hence source function throughout the atmosphere. From the radiance solutions:

$$I(\tau,\mu,\phi) = \left\{ \frac{\mathbf{r}}{\pi} \left[ \pi \mu_0 \mathbf{F} e^{-\tau * / \mu} \mathbf{o} + \int_0^1 \int_0^{2\pi} I(\tau *, -\mu, \phi) \mu d\mu d\phi \right] \right\}$$

+ (1-r) 
$$B[\Theta(\tau^*)] \exp(-(\tau^*-\tau)/\mu] + \int_{\tau}^{\tau^*} J(t,\mu,\phi) e^{-(t-\tau)/\mu} \frac{dt}{\mu}$$
 (2.10)

$$I(\tau, -\mu, \phi) = \int_{0}^{\tau} J(t, \mu, \phi) e^{-(\tau - t)/\mu} \frac{dt}{\mu}$$
 (2.11)

It can be seen that surface reflection can increase both upward and downward radiances through the source function. For upward radiances, there is a more drastic difference between the standard LOWTRAN treatment and the implemented multiple scattering version. This concerns reflection of downward scattered radiance from the surface and back to a downward looking observer (the second term in the brackets in Equation (2.10)). This contribution is not included in standard LOWTRAN although the reflected attenuated direct solar term is (i.e., the first term in Equation (2.10)).

### 3.2.5 Description of LOWTRAN6 with Multiple Scattering

The addition of multiple scattering to LOWTRAN6 has been made with a minimum of changes to the source code and input deck. Only one new input parameter, IMULT, has been added. IMULT, read as the last input on card 1, is set to zero for the original LOWTRAN6 with single scattering and one for the AER LOWTRAN6 with multiple scattering. If aerosols are not included (clear sky case), the original LOWTRAN6 is executed, independent of the value of IMULT.

Source code changes were made primarily in the main program LWTRN6 and in subroutines TRANS, with some additions to EXABIN, AEREXT, EXTDTA, and RFPATH. Subroutines MSRAD, FLXADD, and ALEVEL and functions BETABS and PLANCK were added.

The main program has been altered to allow the path geometry calculations (salled from subroutine GEO) to be accessed twice, once for the original LOWTKAN si gle scatter path and once for the entire atmosphere, required for computation of the multiply scattered radiance. The reason for the second path geometry call is that the thermal and solar source functions used to determine the multiply scattered radiance contribution are functions of the

upward and downward flux at each layer. The multiply scattered flux at a given layer will, in part, be determined by radiation from <u>all</u> atmospheric layers, even those above or below the layers between the observer and target. To calculate the fluxes at each layer, it is therefore necessary to add the flux contributions from the surface up to space, and back down to the surface again. This adding procedure, executed in the new subroutine FLXADD, is discussed in detail in Sections 3.1.2.1 and 3.1.2.2.

A flag (variable ITEST) has been incorporated into RFPATH for the purpose of isolating the refracted viewing path zenith angle for each layer, as opposed to the solar zenith angle, calculated for the solar cases in a later pass through RFPATH.

A number of changes were incorporated into subroutine TRANS. After calculating the cumulative path parameters used in the original LOWTRAN6, it calls MSRAD, where the aerosol scattering and extinction, H<sub>2</sub>O continuum and Rayleigh scattering optical thickness for each layer are calculated. The asymmetry factor for each layer is also calculated based on model extinction and absorption data added to EXABIN, AEREXT, and EXTPTA, and aerosol effective absorber amounts for the four vertically spaced aerosol regions. MSRAD calls subroutine FLXADD.

Subroutine FLXADD calculates the six degraded k components of the H2O/ uniformly mixed gas transmission for each layer, as well as the molecular absorption optical thickness. It is then added to the continuum, aerosol extinction, and molecular scattering optical thickness from MSRAD to provide the total optical thickness for each layer and k-value, as well as the corresponding single scatter albedo. The diffuse flux contribution for each isolated layer and k-value is computed from the applicable two-stream approximation, either solar or thermal, and combined in the flux adding routine to determine the total upward and downward flux for each layer for each k value. The diffuse solar downward flux is summed over k value and returned to evaluate the surface reflected downward diffuse solar flux. Function PLANCK returns the black body radiance for a particular wavenumber and temperature in units of  $Wcm^{-2}$  sterad<sup>-1</sup>/cm<sup>-1</sup>, while subroutine ALEVEL returns the layer number corresponding to a particular height, the top layer of the atmosphere being layer 1. Knowing the upward and downward fluxes as well as the backscatter parameter  $\beta$  returned from function BETABS, the multiple scattered source function can be determined.

Returning to MSRAD, the radiance is summed over the viewing path (between Hl and H2) and k-values to provide the multiply scattered diffuse radiance contribution. For a downward looking (upward radiance) calculation, the multiply scattered radiance at the upper boundary may be expressed by

$$I^{+}(n_{t}) = \sum_{k=1}^{6} \left\{ (1-T_{n_{t}}^{i}) S(k,n_{t}) + \sum_{i=n_{t}}^{n_{b}-1} (T_{i+1}^{i} - T_{i}) S(k,i+1) \right\} \Delta g_{k} + I_{s} (3.39)$$

where  $n_b$  is the bottom layer,  $n_t$  the top layer, S(k,i) the source function for a particular k value and layer i.  $T_1'$  is the transmission from the upper boundary (H2) through layer i along the viewing path. The total upward radiance also includes  $I_s$ , a direct solar reflection surface contribution or surface thermal emission term, which for the new AER LOWTRAN includes the contribution due to the reflection of the single and multiple scattered solar radiance. For a thermal case,

$$I_{s} = B_{s} T_{t} \varepsilon \tag{3.40}$$

where  $B_s$  is the black body function for a given surface temperature and frequency,  $T_t$  is the total atmospheric transmissivity, and  $\epsilon$  is the surface emissivity. For the old LOWTRAN (single scatter) solar case,

$$I_{s} = a \mu_{o} T_{t} S/\pi,$$
 (3.41)

where  $a_s$  is the surface albedo,  $\mu_0$  the cosine of solar zenith angle at the surface, and S the direct solar intensity at the surface. With multiple scattering (IMULT=1), the single and multiple scatter reflection terms are added, so that

$$I_{s} = a_{s} \mu_{0} T_{r} S / \pi + a_{s} F_{s} T_{r} / \pi, \qquad (3.42)$$

where  $F_s^-$  is the downward diffuse flux at the surface.

For an upward looking (downward radiance) case, the multiply scattered radiance is expressed by

$$I^{-}(n_b) = \sum_{k=1}^{6} \left\{ (1 - T_{n_b}) \ S(k, n_b) + \sum_{i=n_b}^{n_t+1} (T_i - T_{i-1}) \ S(k, i-1) \right\} \Delta g_k, \quad (3.43)$$

where  $T_i$  is the transmission from the lower boundary (H1) through layer i along the viewing path. At this point, the LOWTRAN6 path parameters are reloaded, and TRANS is executed once more for the single scatter LOWTRAN6 case. The single scatter diffuse radiance is added to the multiple scatter

term and the boundary radiance contributions (if any) to yield the total thermal radiance, while the solar/lunar radiance is the sum of the single and multiple scatter terms plus a surface reflection term where applicable. MSRAD and FLXADD are not called for the LOWTRAN6 single scatter case.

Figures 3-9 and 3-10 are flow charts of subroutines TRANS, MSRAD, and FLXADD.

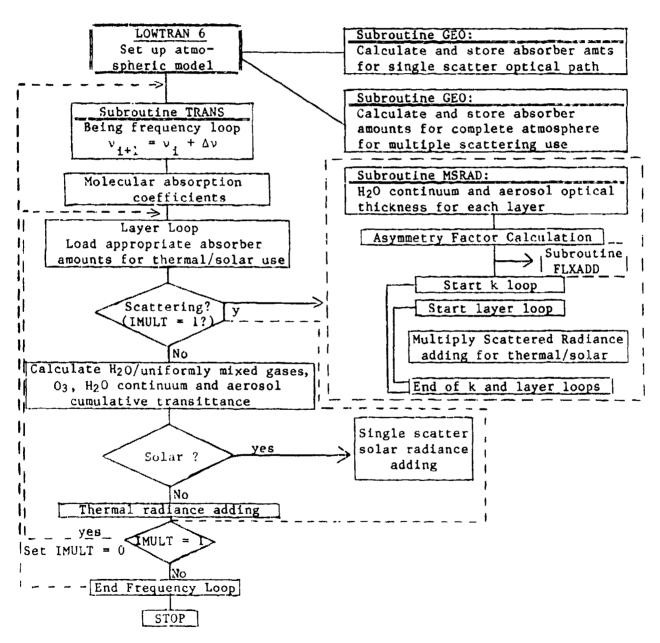


Figure 3-9. Flowchart of Subroutines TRANS and MSRAD.

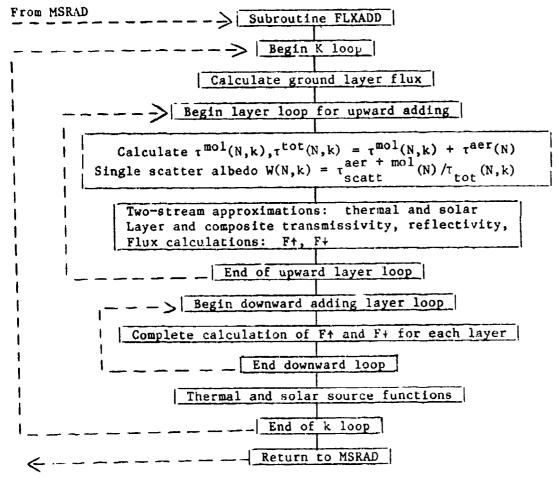


Figure 3-10. Flowchart of Subroutine FLXADD.

### 3.2.6 Notes on the Operation of LOWTRAN6 with Multiple Scattering

As previously discussed, the only change to the LOWTRAN input card images occurs in card I with the addition of the input parameter IMULT used to turn multiple scattering on or off. Card I is now read as follows:

As previously mentioned, setting IMULT = 1 initiates multiple scattering, while IMULT = 0 provides single scattering or clear sky results.

Unlike the original LOWTRAN6, the new LOWTRAN6 requires a complete atmospheric profile (surface to space) to properly calculate the multiple scattering contribution to the radiance. For a calculation involving a path from 0-1 km, for example, it is still necessary to choose the desired stratospheric as well as higher level aerosol distribution set by IVULCN on card 2. For a 3-20 km path, the boundary layer aerosols, set using IHAZE, on card 2 or user-defined via card 2D, will now affect the calculated radiance. The original LOWTRAN performing single scattering required aerosol information only along the path between observer and target.

As currently set up, LOWTRAN6 will not do multiple Rayleigh coattering for IHAZE = 0 but will instead default to the original LOWTRAN6 single scattering calculation. To perform a multiple Rayleigh scattering calculation without boundary layer aerosols, choose IHAZE > 0 and set the visibility (VIS on card 3) to a large value such as 300 km to effectively eliminate the effect of these aerosols.

When LOWTRAN6 is run in its original for (single scattering only, IMULT = 0), the output for a solar case includes the reflected attenuated direct solar radiance under the heading GROWND REFLECTED. However, in many cases, the ground reflected diffuse radiance due to single and multiple scattering is on the same order of magnitude as the direct reflected radiance. The output for new LOWTRAN6 (IMULT = 1) has therefore been altered to include both the total (diffuse single and multiple scattered and direct) and direct reflection terms. Since the original single scatter LOWTRAN does not calculate downward radiance at the surface for an upward radiance case, the single scattered diffuse reflection term cannot currently be calculated.

Running LOWTRANÓ with multiple scattering results in a several-fold increase in CPU time. The atmospheric profile and path being used may not produce a significant multiple scattering contribution, possibly resulting in wasted computer time. A new feature has therefore been added to the solar output. Both the total (single and multiple) and single scattered radiance are now included under the heading "PATH SCATTERED RADIANCE." If in doubt, the user may now run a multiple scatter LOWTRAN run to determine the relative size(s) of the single and multiple scatter contributions. If multiple scattering is negligible, future calculations may be made with the more economical single scatter (IMULT = 0) option.

Test cases for LOWTRAN are provided in Appendix C.

# 4. RESULTS OF INTERCOMPARISON OF IMPLEMENTED MULTIPLE SCATTERING APPROACH WITH EXACT CALCULATIONS

### 4.1 Comparison of FASCODE Multiple Scattering Results to Exact Calculations

The detailed approach described in the previous sections was employed to develop a multiple scattering version of FASCODE based on the stream approximation and adding method. In order to verify the operation of the code, a number of test cases were run. To validate the results, these test cases were also run with the discrete ordinate code (DOM) for multiple scattering. Additionally, the existing nonscattering version of FASCODE was run for comparison. The optical properties for these test cases and corresponding radiance results are given in Table 4-1(a)-(c). Three test cases were selected. Case I is based on a FASCODE run at 900 cm-l with a rural haze and 5 km visibility. This resulted in an optical depth of 0.357 and a single scattering albedo of 0.126. With this small albedo, the effects of scattering are expected to be small and results for all three methods should be comparable. In order to enhance the scattering effects and emphasize the differences between approaches, the number density of aerosol was increased to nonphysical amounts to yield single scattering albedos in the vicinity of 0.5 (case II ) and 0.9 (case III). Note that the FASCODE models include the effect of atmospheric refraction while the discrete ordinate method code is strictly a plane parallel model. Comparisons of these results for zenith angles in the domain from 65 to 115 degrees should be made with this in mind.

Results are plotted in Figures 4-1 to 4-6. Upward and downward emergent radiances for Case I are shown in Figures 4-1 and 4-2, respectively. Here FASCODE, FASCODEMS, and the DOM are shown to give approximately the same magnitude and angular distribution of radiance. A slight tendency for FASCODE to underestimate the upward radiance and overestimate the downward radiance can be noted. At a higher optical depth and single scattering albado (case II), this effect becomes obvious (Figures 4-3 and 4-4, respectively.) Here it can be seen that FASCODEMS does a clearly superior job at representing the angular radiance distribution. For a situation where multiple scattering dominates over gas absorption (case III, Figures 4-5 and 4-6), the deficiency of the absorption only FASCODE model is obvious.

Table 4-1

Scattering Comparisons for FASCODE Multiple Scattering Runs

(WAVELENGTH = 900 CM-1, RADIANCES = ERG SEC-1 CM-2 (CM-1)-1 STR-1)

(a) CASE I. SMALL SCATTERING

TAU=0.357, OMEGA0=0.126, ASYMMETRY FACTOR=0.6985

ZENITH ANGLE (DEGREES)	AFGL FASCODE (NO MS)	AER FASCODE (MS)	DISCRETE ORDINATE METHOD (MS)
	UPWARD RA	ADIANCES	
0.000	101.29	102.55	106.24 †
8.349	100	102.42	103.07
19.165	11.	101.84	102.45
30.045	· · ·	100.69	101.23
40.939	>/ <b>.</b> 29	98.75	99.18
51.839	94.02	95.58	95.81
62.741	88.62	90.23	90.09
73.644 *	79.17	80.66	79.61
84.548 *	68.23	68.29	60.96
	DOWNWARD I	RADIANCES	
95.452 *	65.16	63.44	68.51
106.356 *	46.79	44.37	46.72
117.259	35.15	32.85	34.09
128.161	28.48	26.36	27.12
139.061	24.43	22.48	23.01
149.955	21.92	20.11	20.49
160.835	20.41	18.70	19.00
171.651	19.64	17.98	18.24
180.000	19.47	17,81	14.69 †

<sup>†</sup>This point extrapolated in discrete ordinate method.

<sup>\*</sup>FASCODE path is refracted while discrete ordinate method is plane parallel. These zenith angles are affected.

(2) CASE II. INTERMEDIATE SCATTERING

TAU=0.555, OMEGAO=0.498, ASYMMETRY FACTOR=0.6985

ZENITH ANGLE (DEGREES)	AFGL FASCODE (NO MS)	AER FASCODE (MS)	DISCRETE ORDINATE METHOD (MS)
(0000000)	(NO N5)	·····	
	UPWARD RA	DIANCES	
0.000	94.73	101.62	103.52 †
8.349	94.55	101.48	101.43
19.165	93.77	100.85	100.69
30.045	92.25	99.63	99.21
40.939	89.79	97.53	96.68
51.839	86.00	94.02	92.50
62.741	80.24	88.21	85.45
73.644 *	71.93	78.66	73.33
84.548 *	68.01	68.06	55.37
	DOWNWARD 1	RADIANCES	
95.452 *	66.48	59.53	70.14
106.356 *	56.04	44.76	50.95
117.259	45.63	34.02	37.25
128.161	38.49	27.40	29.14
139.061	33.78	23.35	24.28
149.955	30.72	20.89	21.32
160.835	28.84	19.46	19.58
171.651	27.87	18.71	18.70
180.000	27.65	18.55	16.80 †

(c) CASE III. LARGE SCATTERING

TAU=0.308, OMEGAO=0.897, ASYMMETRY FACTOR=0.6985

ZENITH ANGLE (DEGREES)	AFGL FASCODE (NO MS)	AER FASCODE (MS)	DISCRETE ORDINATE METHOD (MS)
	UPWARD R	ADIANCES	
0.000	103.31	112.24	119.78 †
8.349	102.97	112.19	113.19
19.165	102.45	111.96	112.81
30.045	101.46	111.49	112.03
40.939	99.78	110.53	110.58
51.839	97.01	108.57	107.87
62.741	92.28	104.51	102.49
73.644 *	83.37	95.13	90.55
84.548 *	68.85	68.79	62.28
	DOWNWARD	RADIANCES	
95.452 *	63.04	46.54	57.61
106.356 *	41.52	21.81	28.65
117.259	30.60	12.71	16.29
128.161	24.75	8.72	10.68
139.061	21.33	6.78	7.84
149.955	19.24	5.83	6.31
160.835	18.00	5.37	5.48
171,651	17.37	5.14	5.09
180.000	17.23	5.09	†

In order to gain some insight into the differences between the FASCODE and FASCODEMS results, a radiance budget has been computed for one upward and one downward zenith angle corresponding to case II. These radiance budgets are presented in Table 4-2 and provide the magnitude of contributions to the total radiance from surface emission, atmospheric emission, and the scattering source function, as applicable. Radiance values are rounded for simplicity.

Table 4-2

Case II Radiance Budgets [unattenuated surface emission corresponds to 120 radiance units; units = erg s cm str (cm)].

	FASCODE	FASCODEMS	DOM	
(a) Upward Radiance (zenith angle 8.3	degrees)			
Surface emission	65	65		
Atmospheric emission	30	16		
Scattering source		20		
Total	95	101	101	
(b) Downward Radiance (zenith angle 171.	7 degrees)			
Atmospheric emission	28	12		
Scattering source	-	8		
Total	28	20	19	

Examination of Table 4-2 indicates that FASCODE over estimates atmospheric emission in the presence of scatterers since it assumes that scattering extinction is equivalent to absorption. In this case radiation absorbed is re-emitted. While scatterers may absorb and re-emit, some fraction of the extinction due to their presence (i.e., that given by their single scattering albedo) is simply redirected. In the case of the upward intensity in Table 4-2, forward scattering of some of the surface emission lost due to extinction more than compensates for the decreased atmospheric emission. Thus the non-scattering version of FASCODE underestimates the radiance. For the downward radiance in Table 4-2, the small scattering source does not compensate for the decrease in atmospheric emission due to the treatment of scattering. In this case FASCODE overestimates the actual radiance.

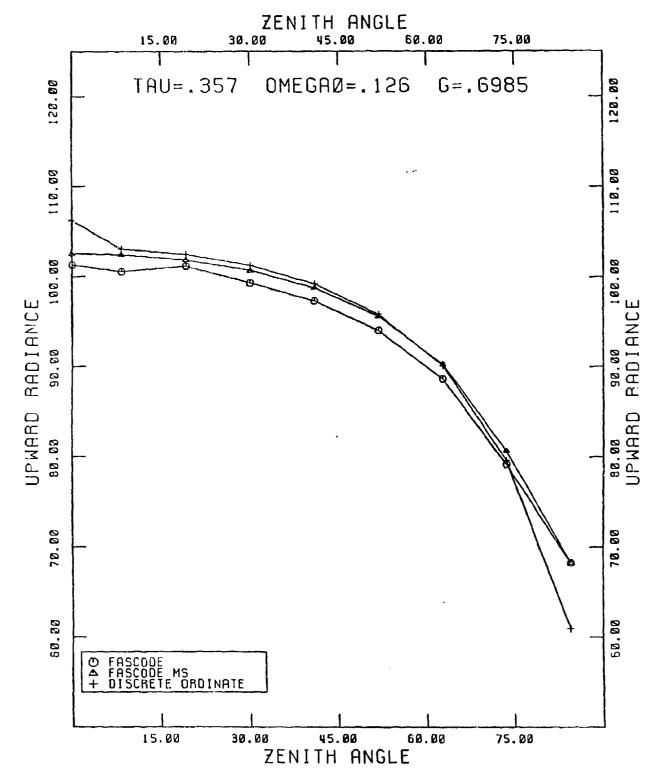
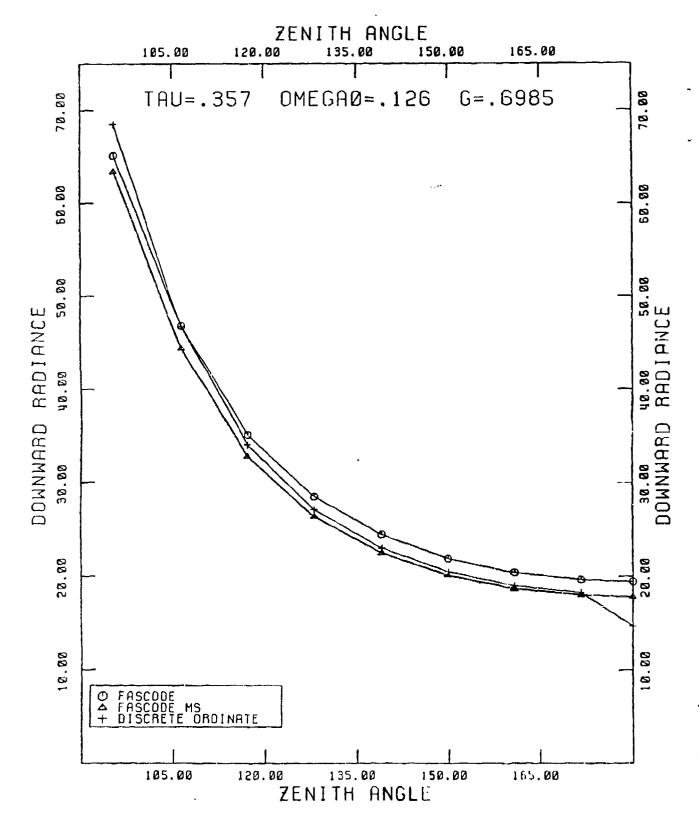


Figure 4-1. Comparison of FASCODE, FASCODEMS, and DOM for upward radiance [units: ergs  $\sec^{-1}$   $cm^{-2}$   $str^{-1}$   $(cm^{-1})^{-1}$ ]



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Figure 4-2. Comparison for FASCODE, FASCODEMS, and DOM for downward radiance [units: ergs  $\sec^{-1}$   $\csc^{-2}$   $\sec^{-1}$   $(\csc^{-1})^{-1}$ ]

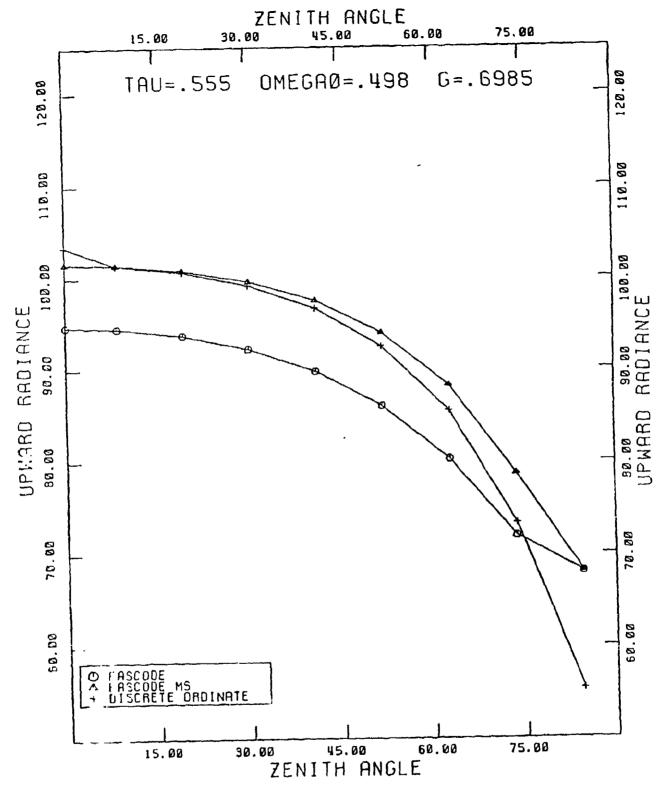


Figure 4-3. Comparison of FASCODE, FASCODEMS, and DOM for upward radiance [units: ergs sec 1 cm 2 str 1 (cm 1) 1]

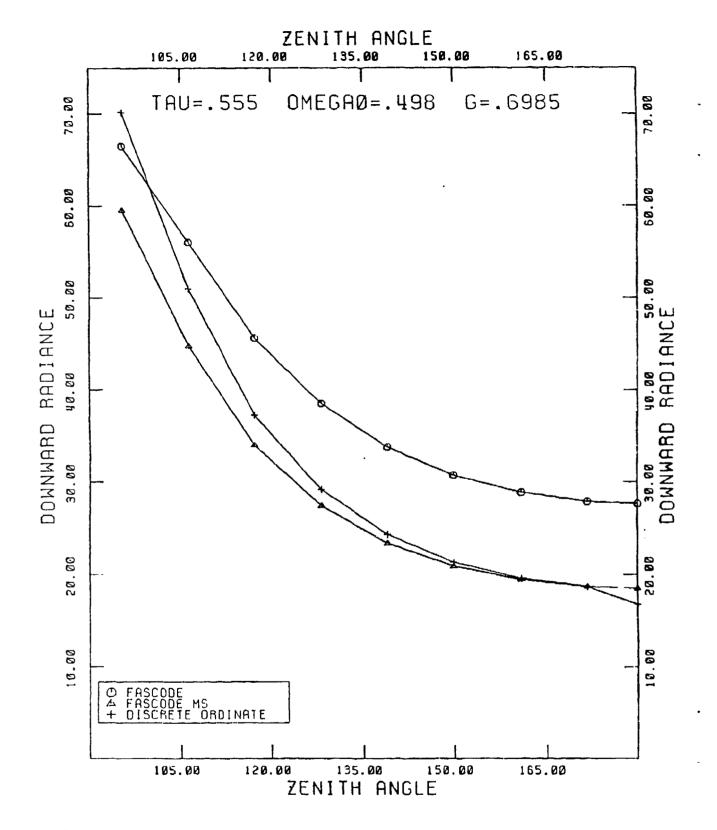


Figure 4-4. Comparison for FASCODE, FASCODEMS, and DOM for downward radiance [units: ergs  $\sec^{-1}$  cm<sup>-2</sup> str<sup>-1</sup> (cm<sup>-1</sup>)<sup>-1</sup>]

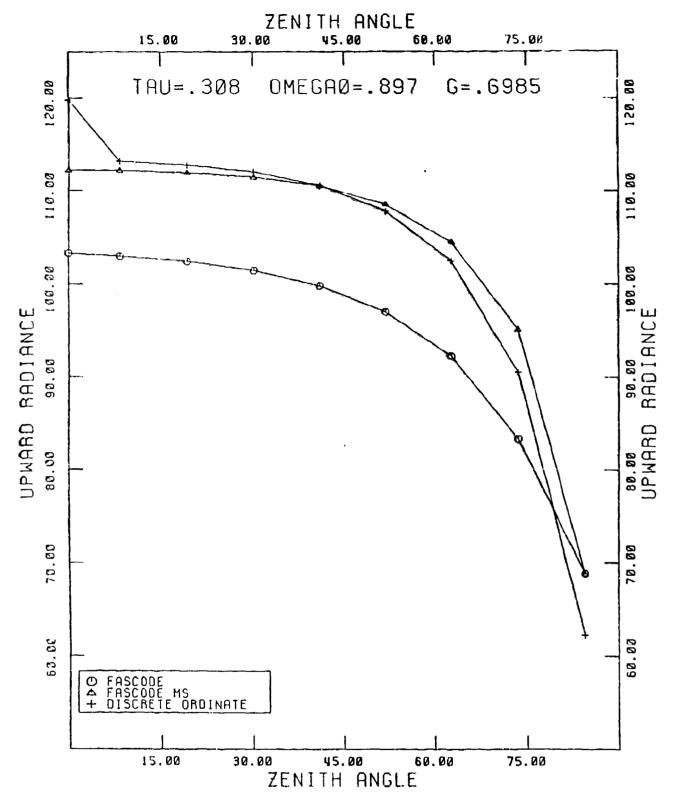


Figure 4-5. Comparison of FASCODE, FASCODEMS, and DOM for upward radiance [units: ergs  $\sec^{-1}$   $\csc^{-2}$   $\sec^{-1}$   $(\csc^{-1})^{-1}$ ]

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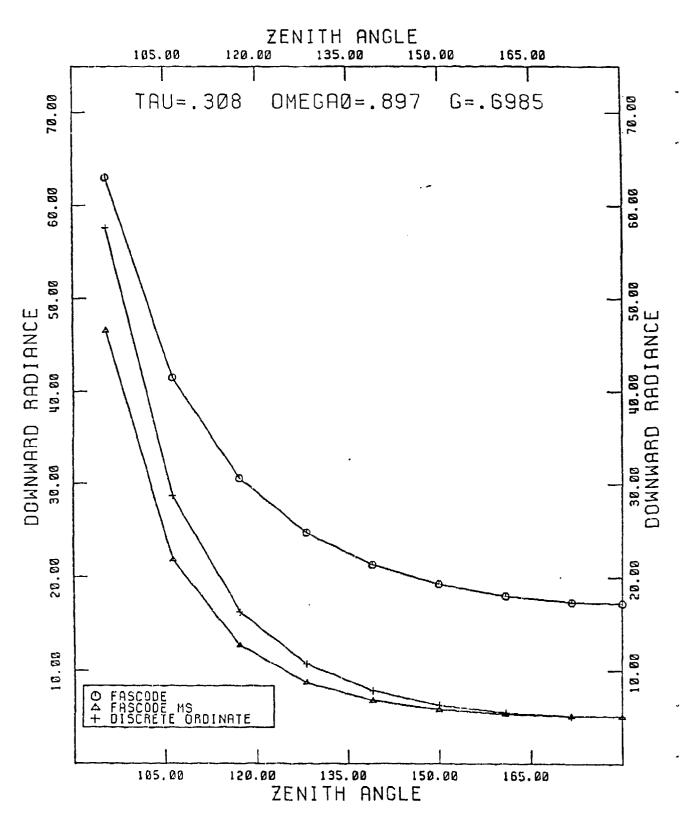


Figure -6. Comparison for FASCODE, FASCODEMS, and DOM for downward radiance [units: ergs  $\sec^{-1}$  cm<sup>-2</sup>  $\sec^{-1}$  (cm<sup>-1</sup>)<sup>-1</sup>]

# 4.2 Comparison of LOWTRAN Multiple Scattering Results to Exact Calculations

## 4.2.1 Solar Multiple Scattering

In order to verify the correct operation of the implemented LOWTRAN multiple scattering treatment for both solar and thermal regimes, comparisons were made to exact results.

In the case of solar multiple scattering, exact results were obtained for a variety of cases during the trade-off analysis summarized in Appendix A. Exact solutions to the radiative transfer equation for solar multiple scattering were obtained using the Gauss-Seidel iterative method based on a code by Dave (1972). This algorithm evaluates the fluxes and radiances for inhomogeneous atmospheres with arbitrary vertical distributions of anisotropically scattering aerosol overlying a Lambert reflecting surface. Emergent fluxes and radiances from this code were compared to those obtained from LOWTRAN for three values of total optical thickness (0.25, 0.50, 1.00) and two values of surface albedo (0.0, 0.4).

A number of special modifications of LOWTRAN were necessary to accommodate the comparison. These included reading in the same aerosol extinction and absorption coefficients, asymmetry factor, and phase function as were used for the Dave model runs, and forcing LOWTRAN to use the quantities with the same vertical distribution as the Dave code. (Ordinarily, user supplied aerosol data read into LOWTRAN will only be used in the lowest 2 km of the atmosphere.) These changes made the comparison as close as possible to a direct one. The LOWTRAN code was run at 0.55 µm with the sun at a zenith angle of 60°.

The first test of the LOWTRAN implementation is whether the adding method is calculating the correct fluxes for use in the stream approximation of the multiply scattered source function. Table 4.3 compares the emergent fluxes calculated by the exact code and LOWTRAN. For simplicity all fluxes and radiances plotted here have been normalized to correspond to  $\pi$  units of incident solar irradiance. To obtain the appropriate engineering units (watts/cm² cm²¹, and watts/cm² str cm²¹, for flux and radiance, respectively), the normalized values can be multiplied by 1.719 ×  $10^{-5}$ . As can be seen from the results, the solar two stream approximation and flux adding procedure in LOWTRAN is reproducing the exact values quite well throughout the range of

optical thicknesses and surface albedos examined. The errors, on the order of a few percent, are to be expected from the two stream approximation.

Figures 4-9 through 4-12 illustrate the comparison between the exact radiance calculation as a function of path zenith angle (theta) and those obtained from LOWTRAN using either the solar single scattering option (LCWTRAN) or the new multiple scattering option (LOWTRAN MS). Plotted are the normalized emergent upward and downward radiances for an optical depth of 0.5 and surface albedos of 0.0 and 0.4. The plots extend to a maximum zenith angle of 60° since at larger angles the effects of refraction in the LOWTRAN code make it difficult to compare to the plane parallel exact results. In all cases it can be seen that the introduction of the multiply scattered contribution to path radiance in LOWTRAN MS has considerably improved the simulation as compared to that obtained from the exact code. The improvement is considerable, especially for upward radiance when there is surface reflection (see Figure 4-11). This is because although the single scatter version of LOWTRAN included the surface reflection of the attenuated direct solar beam, it contained no provision to treat the reflected downward scattered radiance. This contribution (which is the second term in the brackets in Equation (2.10)) may be considerable when multiple scattering is a factor and is included in the LOWTRAN MS version since the downward scattered flux is calculated as a result of the adding method.

The relative accuracies as a funtion of path zenith angle expressed as percent errors obtained in the comparisan between LOWTRAN MS and the exact calculations for all optical depths evaluated are summarized in Figures 4-13 and 4-14, for surface albedos of 0.0 and 0.4, respectively. In general, the solar multiple scattering approach implemented within LOWTRAN underestimates radiance by 10 or 20 percent. These accuracies are consistent with those obtained off line in the trade-off analysis (see Appendix A, Table A-5.)

### 4.2.2 Thermal Multiple Scattering

Froper operation of the code for thermal multiple scattering was verified by comparing LOWTRAN MS to corresponding FASCODE MS results. FASCODE MS has been compared to exact multiple scattering using the discrete ordinate method in Section 4.1. The case chosen was a vertical path from the surface to 20 km using a U.S. Standard atmosphere (MODEL 6) and a rural aerosol model

with 5 km visual range (IHAZE 2). The spectral domain for both runs was 850-i150 cm<sup>-1</sup>. Figures 4-15a, b illustrate this comparison for upward and downward radiance, respectively. The FASCODE MS results have been degraded to 5 cm<sup>-1</sup> for consistency with the LOWTRAN MS values. In general both models agree quite well within this spectral region. The slight discrepancy between degraded FASCODE and LOWTRAN spectra (especially for downward radiance) in this region is not due to multiple scattering effects, but rather to differences in the corresponding clear air spectra. This is illustrated by Figure 4-16 where all aerosols have been removed from the calculation.

One problem with the previous treatment of thermal scattering within LOWTRAN was the failure to provide a source function to introduce multiply scattered radiance contributions along the observed path. As a consequence of this ad hoc approach, LOWTRAN seriously underestimated path radiance for long paths such as those near the horizon where multiple scattering could contribute significantly (Ben-Shalom et al., 19 This deficiency is corrected with the implementation of the multiple scattering approach descibed here. To illustrate, radiances have been simulated for a ground based observer scanning the sky between 8.0 and 13.5 µm. Figures 4-17,4-18, and 4-19 illustrate the calculated results, for observing zenith, 10° above the horizon, and the horizon, using the standard LOWTRAN, the Ben-Shalom modification (Ben-Shalom et al, 1980), and LOWTRAN MS. For comparison, the black body function of the lowest atmospheric layer is also plotted. The calculation has assumed a midlatitude summer atmosphere and 5 km visual range.

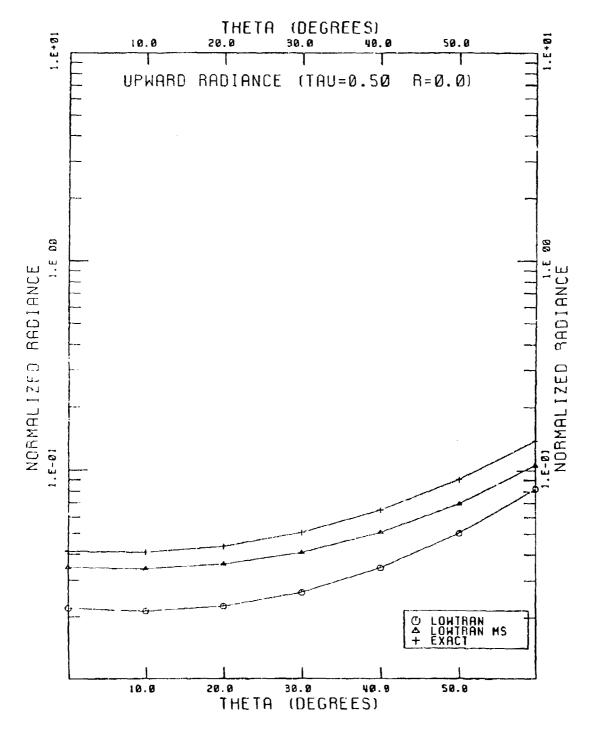
As can be seen in Figure 4-17, there is very little difference in the results among the three approaches when observing zenith when multiple scattering effects are minimized. For larger air mass factors, however, the three approaches diverge, with the LOWTRAN MS result bounded below by the standard LOWTRAN and above by the Ben-Shalom modified version (see Figure 4-18). This is understandable since standard LOWTRAN removes all scattered radiance from the path radiance and the Ben-Shalom modification assumes that all scattered radiance is returned to the path radiance (i.e., the scattering is conservative). Actually some of the scattered radiance is returned to the path radiance through the scattering source function. The fraction returned derends on the single scattering albedo and through the scattering phase function, on the viewing geometry. At the horizon (Figure 4-19), the standard LOWTRAN result

significantly underestimates the radiance level expected qualitatively, i.e., that approximating the emission of the lowest atmospheric layer.

In Figure 4-20a are plotted LOWTRAN MS results for the case described above with the observer path at various elevation angles. For comparison, Figure 4-20, reproduces a set of radiance measurements taken with qualitatively similar conditions (Bell et al,1960). Note that the wavelength range of these measurements is much broader than that illustrated in Figure 4-20a and the vertical scales are different. Additionally, the ambient temperature when the measurements were taken is about 5 K higher than that of the surface layer of the midlatitude summer model used in the LOWTRAN MS simulation. In spite of these differences, the simulated and measured radiances exhibit similar magnitudes and dependence on path elevation angle.

Table 4-3 Comparison of solar multiply scattered emergent fluxes (normalized to  $\pi$  units of incident irradiance) from LOWTRAN FLXADD subroutine (L) and exact calculation (E).

*********	Upward Flux F <sup>†</sup> (π = 0)		Downward Flux F (π = π*)	
π*	r = 0.0 L / E	r = 0.4 L / E	1	r = 0.4 L / E
0.25	.188 / .191	.611 / .634	.323 / .316	.367 / .371
0.50	.244 / .256	.562 / .584	.503 / .489	.536 / .544
1.00	.316 / .324	.492 / .515	.599 / .567	.605 / .615



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Figure 4-9. LOWTRAN6 upward radiance (solar, .55  $\mu m)$  with and without multiple scattering comapred to exact (Dave) results. Solar zenity angle is 60°.

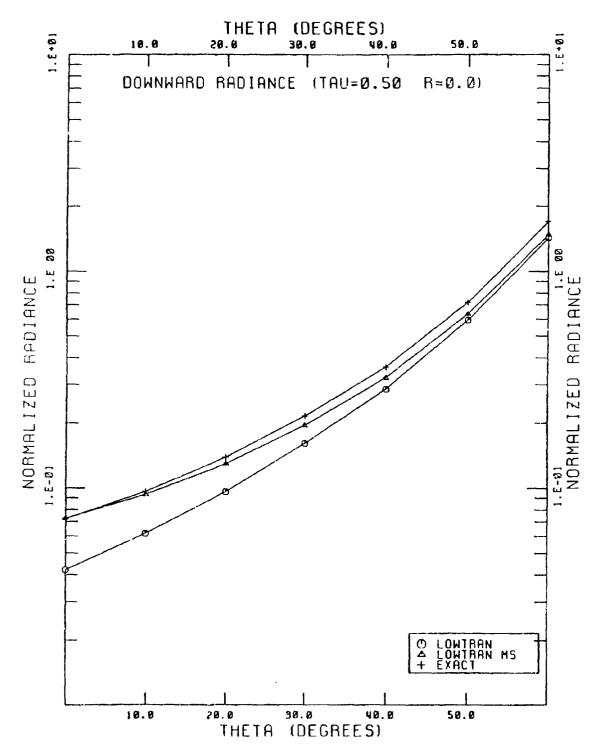


Figure 4-10. LOWTRAN6 downward radiance (solar, .55 mm) with and without multiple scattering compared to exact (Dave; results. Solar zenith angle is 60°.

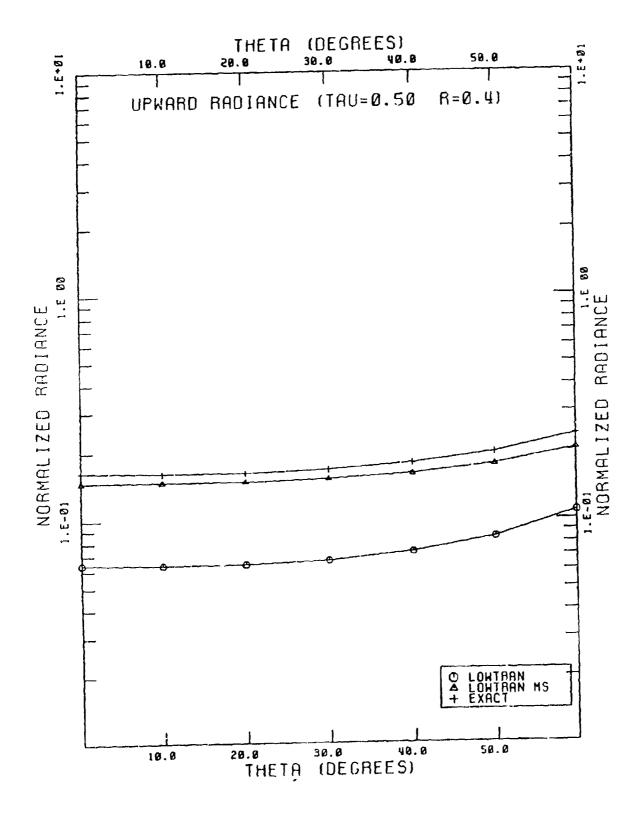
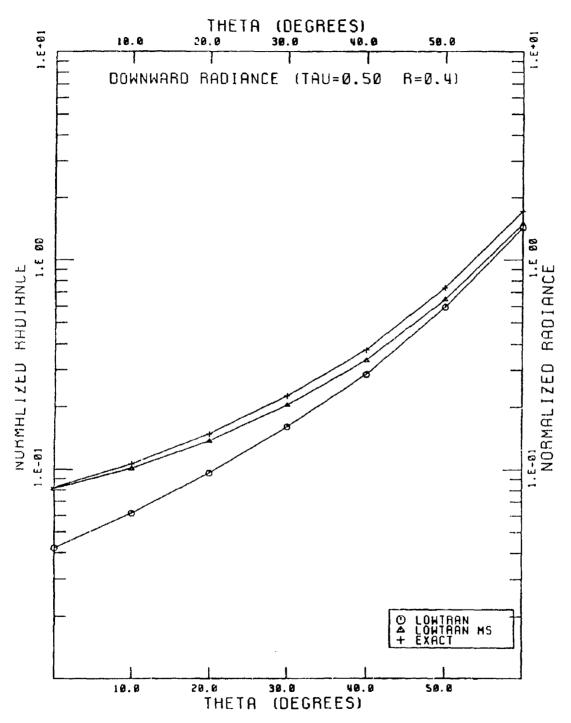


Figure 4-11. LOWTRAN6 upward retinge (solar, .55  $\mu$ m) with and without multiple scattering content to exact (Dave) results. Solar zenity angle is 60°.



ligare 4-12. LOWTRAN6 downward radiance (solar, .55  $\mu$ m) with and without multiple scattering compared to exact (Dave) results. Solar zenith angle is 60°.

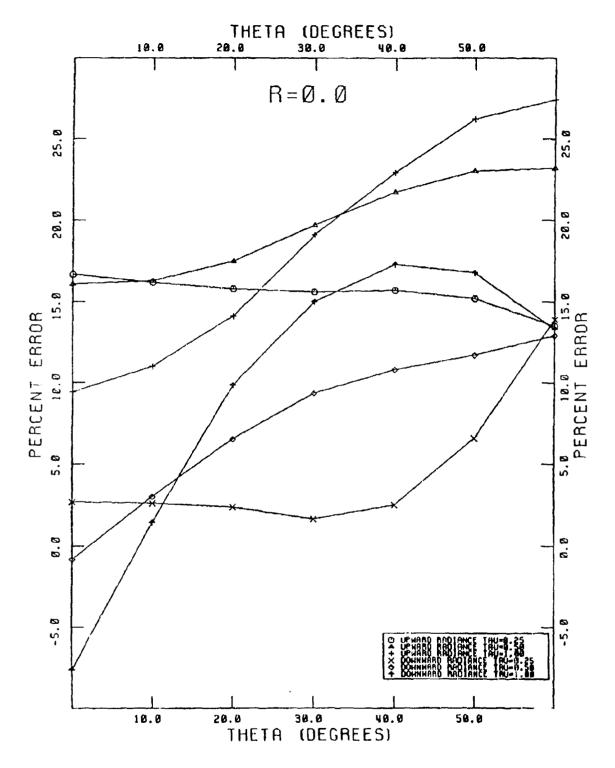
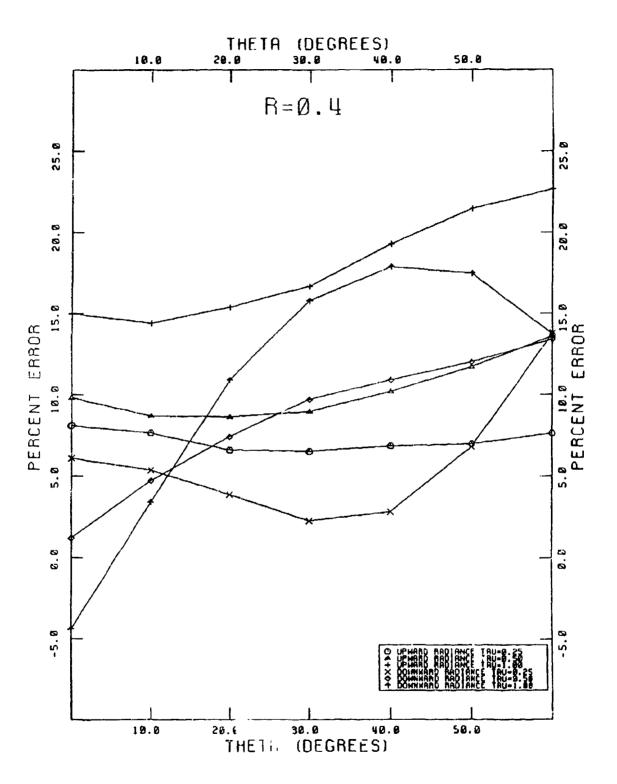


Figure 4-13. Percent error of LOWTRAN6 multiple scatter calculations relative to exact (Dave) results for optical depths between 0.25 and 1.00 with a surface reflectance of 0.0.



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Figure 4-14. Percent error of LOWTRAN6 multiple scatter calculations relative to exact (Dave) res its for optical depths between 0.25 and 1.00 with a surface reflectance of 0.4.

# WAVELENGTH (MICROMETERS)

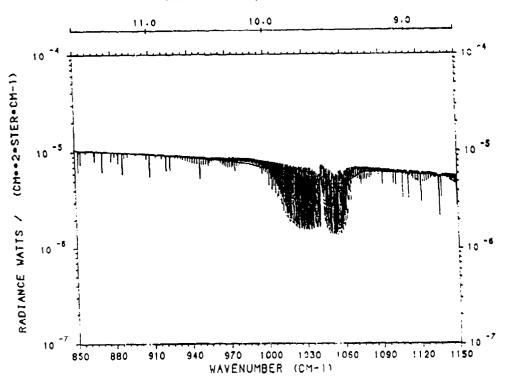


Figure 4-15a. Comparisons of LOWTRAN and FASCODE upward thermal radiance (with multiple scattering) between 850 and 1150 cm $^{-1}$ .

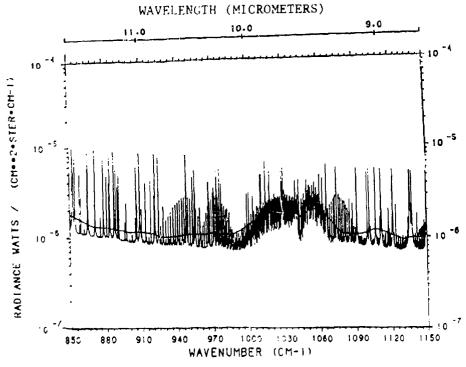


Figure 4-15b. Comparison of LOWTRAN and FASCODE downward thermal radiance (with multiple scattering) between 850 and 1150 cm<sup>-1</sup>.

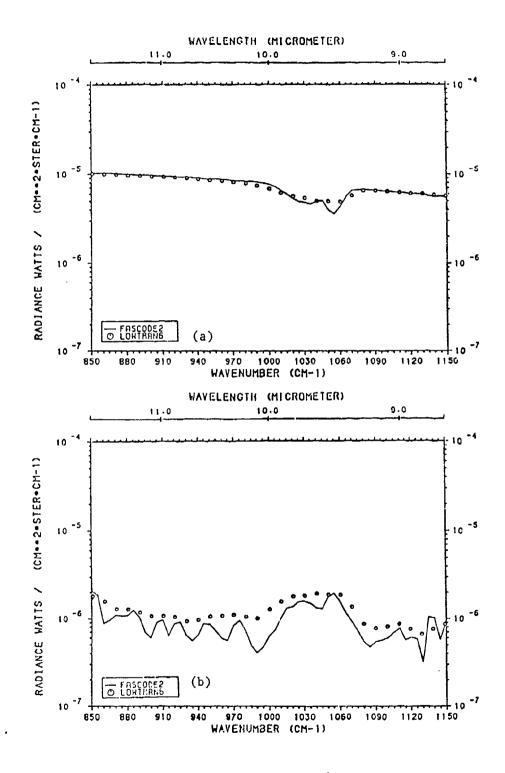


Figure 4.16. Comparisons of clear sky upward (a) and downward (b) radiances between LOWTRAN6 and FASCODE2.

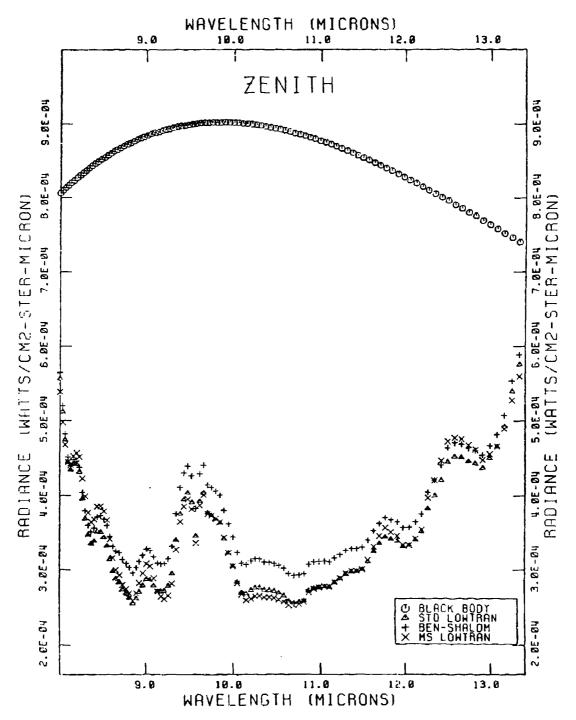


Figure 4-17. Downward thermal radiance comparison between 8 and 13.5 µm:
Black body radiance of lowest atmospheric layer, standard
LOWTRAN (without multiple scattering), Ben-Shalom calculations,
and new LOWTRAN (with multiple scattering). Viewing path is
from surface to zenith.

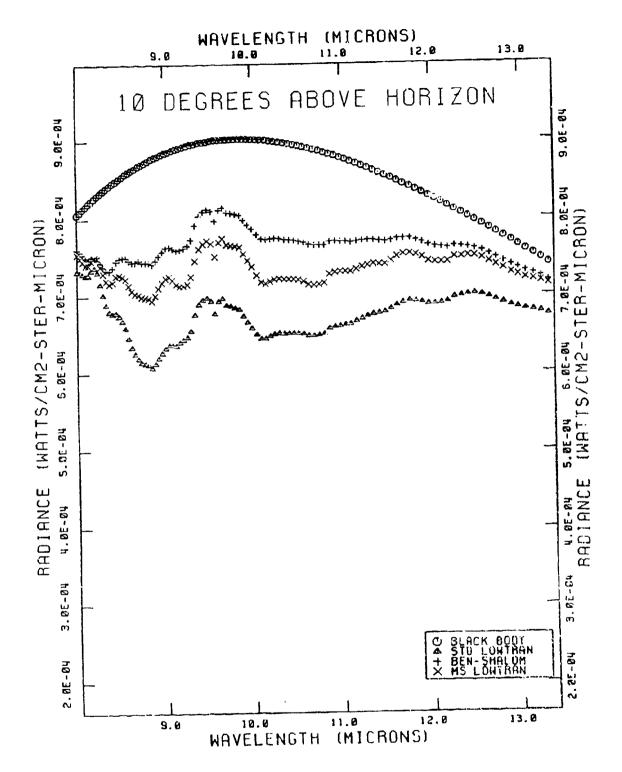


Figure 4-18. Downward thermal radiance comparison between 8 and 13.5 µm: Black body radiance of lowest atmospheric layer, standard LOWTRAN (without multiple scattering), Ben-Shalom calculations, and new LOWTRAN (with multiple scattering). Viewing path is from the surface to space with a zenith angle of 80° (10° above horizon).

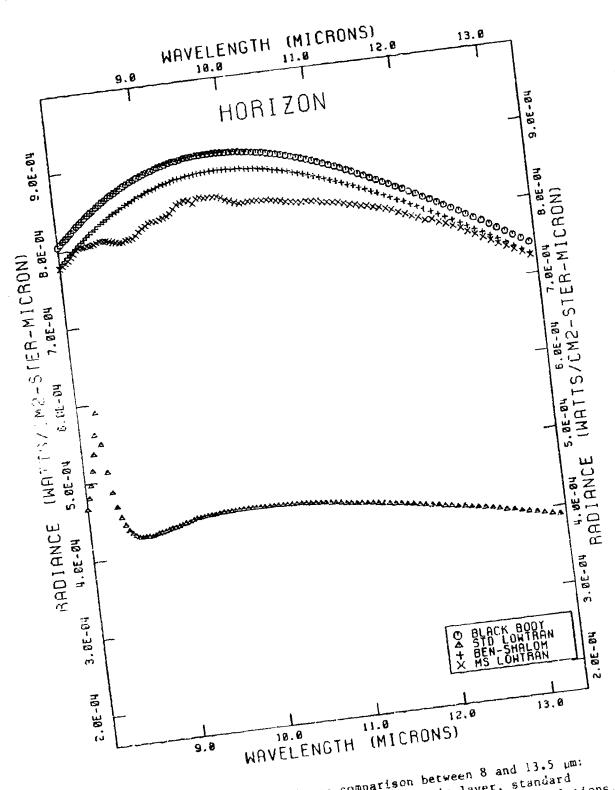


Figure 4-19. Downward thermal radiance comparison between 8 and 13.5 µm:

Black body radiance of lowest atmospheric layer, standard

Black body radiance of lowest atmospheric layer, standard

Black body radiance of lowest atmospheric layer, standard

Black body radiance of lowest atmospheric layer, standard

Black body radiance of lowest atmospheric layer, standard

Black body radiance comparison between 8 and 13.5 µm:

Black body radiance comparison between 8 and 13.5 µm:

Black body radiance of lowest atmospheric layer, standard

Black body radiance of lowest atmospheric layer, standard

LOWTRAN (without multiple scattering), Ben-Shalom calculations, and new LOWTRAN (with multiple scattering). Viewing path is from the surface to the horizon.

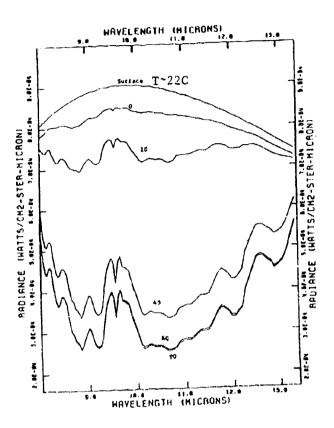


Figure 4-20a.

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Downward thermal radiance results from LOWTPAN with multiple scattering (8.0 to 13.5 µm). Viewing path elevation angle varies between 0 to 90°. Also included is the black body radiance of the lowest atmospheric layer (722°C).

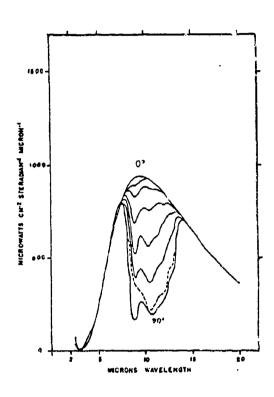


Figure 4-20b.

Downward radiance measurements for various viewing angles under atmospheric conditions qualitatively similar to those of Figure 4.20a (from Bell et al., 1960).

#### 5. SUMMARY AND CONCLUSIONS

#### 5.1 Summary

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The goal of this research has been to provide a suitable parameterization of multiple scattering for implementation within the LOWTRAN and FASCODE atmospheric transmittance/radiance models developed at AFGL. Due to the comprehensive spectral domains treated by these models it was desired to develop a uniform approach applicable to spectral regions from the ultraviolet to the millimeter wave. Furthermore for consistency, analogous approaches were desired for implementation in LOWTRAN and FASCODE. The specific nature of the chosen approach was also constrained by the requirements of desired accuracy and computational efficiency of these models and additionally by their inherent code structure. Code structure requirements were particularly limiting with respect to the FASCODE model.

After reviewing the relevant radiative transfer literature two potential candidate multiple scattering parameterizations were selected for testing. These were a stream approximation and a successive order of scattering approach. Extensive intercomparison tests were conducted to compare the accuracy and efficiency of these candidate approaches to exact numerical treatments in the solar, thermal, and microwave/millimeter wave scattering regimes. Based on the results of these intercomparisons it was decided that the stream approximation would provide the required degree of accuracy and the least computational level of effort.

Two additional considerations were factors in formulating appropriate approaches to introduce multiple scattering into the LOWTRAN and FASCODE models. First, in the case of LOWTRAN it was necessary to provide an interface between the molecular bearber band model treatment and the multiple scattering parameterization. To accomplish this task the k-distribution method was introduced. The k-distribution method effectively decouples the multiple scattering from the LOWTRAN treatment of a agray gas absorption so that the spectral integration can be done properly.

Secondly, although multiple scattering approaches generally begin with a knowledge of the monochromatic optical properties of the entire path of interest, both LOWIRAN and FASCODE perform transmittance and radiance calculations on a lazer-by-layer basis. Thus, in these models, the properties of the

overall path are not known until the end of the calculation. To further complicate matters, the spectral resolution of each FASCODE layer is determined by the appropriate pressure dependent average line width. Thus, for a given desired spectral domain, the resolution of each FASCODE layer increases with decreasing pressure and monochromatic optical data on the entire desired scattering path is never available. These characteristics of the FASCODE code structure led to the adoption of a layer adding approach in order to accommodate both the stream approximation and the layer-by-layer nature of the calculation.

Path dependent radiances at 900 cm<sup>-1</sup> were calculated using the FASCODE implementation of the multiple scattering parameterization (FASCODEMS), the original FASCODE, and the discrete ordinate method. Comparison of these results indicates that the multiple scattering version of FASCODE provides more accurate radiance distribution in the presence of aerosol scattering. Our parametric studies indicate that accuracies of 15 to 20 percent should be expected. However, this increase in accuracy incurs an additional cost in code execution time. In our timing test, CPU execution times for a multiple scattering run in a three-hundred wave number region (800-1100 cm<sup>-1</sup>), took about 3-1/2 times longer than a standard FASCODE run. Most of this additional time was due to the required spectral merging of stored quantities rather than calculations of the stream approximation. Additionally, multiple scattering runs of FASCODE require three times the temporary storage of regular FASCODE runs. The program size is increased by about 15 percent.

To insure consistency, LOWTRAN and FASCODE multiple scattering results were also compared. A much closer agreement is found between AER LOWTRAN and FASCODE (both use multiple scattering) than those between LOWTRAN6 (uses single scattering) and FASCODE.

### 5.2 Recommendations

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This report has described recommendations and implementations of an approach to provide the LOWTRAN and FASCODE models with a unified treatment of multiple scattering consistent with described levels of accuracy and their respective code structures. Introduction of this capability has a number of implications which require additional consideration. These form the basis of our recommendations.

For FASCODE, the question of solar multiple scattering remains an open issue. Certainly, the line parameter compilation provides the capability to exercise FASCODE well below 2500 cm<sup>-1</sup> where solar effects can influence path radiance. We did not introduce solar scattering into FASCODE since the necessary solar irradiance and single scattering routines from LOWTRAN are not yet a part of FASCODE2. If solar multiple scattering is desired in FASCODE, these routines and the capability to calculate the direct solar contribution and the scattering phase function (i.e., the solar path transmission) should be added to FASCODE, then a suitable coupling to the stream approximation/flux adding code segments could be implemented.

Likewise, although this report has illustrated the applicability of the scattering parameterization to the microwave and millimeterwave region for scattering by precipitation, the FASCODE model does not provide the necessary optical properties for such calculations. Attenuation (i.e., extinction) coefficients for rain are available in FASCODE; however, information on single scattering albedo (or alternatively, the scattering coefficients) and asymmetry factor are not. It would seem a simple matter to provide this data. A simple parameterization of these values in the domain between 19.35 and 231 GHz (0.65 - 7.7 cm<sup>-1</sup>) is available in the interim (Isaacs et al., 1985).

With regard to LOWTRAN, we recommend that the k-values should be part of the laboratory experiments, i.e., they be provided directly from fitting the laboratory measurements of transmission values. The present setup of LOWTRAN can easily accommodate the updated k-values of different gases. The scaling approximation to treat inhomogeneous atmospheric effects needs to also be revised, perhaps utilizing the correlated-k techniques published by Wang and Ryan (1983).

Finally, it is worth noting that although the choice of the stream approximation for multiple scattering for implementation within the LOWTRAN and FASCODE models was not an arbitrary one, other approaches are possible. One criteria which the user may wish to consider is the trade-off between accuracy and computational level of effort. As implemented, the multiple scattering enhancements described here will provide emergent radiances with percent errors generally in the range of 10 to 30 percent for solar scattering and less than 10 percent for thermal scattering. Internal radiances, i.e., those evalauted for paths within the atmosphere, will be somewhat less accurate. These accuracies should be adequate for many simulation requirements. For users requiring higher accuracies, the code changes to LOWTRAN and FASCODE to accommodate multiple scattering have made it possible for experienced users of these models to access the necessary optical properties profiles for input to numerical multiple scattering algorithms. This can be accomplished by further modifying the LOWTRAN and FASCODE models to produce output files of the profiles of optical thickness, single scattering albedo, asymmetry factor, and/or angular scattering function which are used in the set up of the current stream approximation calculation.

Other possible options which may interest knowledgeable users include output of emergent fluxes or flux profiles (made possible by the inclusion of the two stream/adding step done in the stream approximation) and substituting other multiple scattering approximations (such as higher order stream approximations) within the code to obtain more accuracy. One application which we have not explored is the applicability of the implemented code changes to evaluation of multiply scattered visible and infrared radiances by clouds. A variety of exciting avenues are opened with the inclusion of the multiple scattering capability within LOWTRAN and FASCODE.

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#### APPENDIX A

# REVIEW AND TRADE-OFF ANALYSIS OF MULTIPLE SCATTERING PARAMETERIZATIONS

## A.1 Review of Multiple Scattering Parameterizations

Radiative transfer theory provides the mathematical description of the interaction between both external (e.g., incident solar) and internal (e.g., emitted thermal) sources of electromagnetic radiation and the optically active atmospheric constituents of gases and particulates (e.g., aerosols, clouds, and precipitation). The solution to the radiative transfer equation for a scattering atmosphere (Chandrasekhar, 1960; Goody, 1964; Liou, 1980) generally requires a numerical solution. An extensive variety of exact numerical methods have been developed to solve these equations over the years, and excellent review are available (Hansen and Travis, 1974; Shettle and Kuriyan, 1975; Lenoble, 1977). This section will focus on approximate multiple scattering methods which can be used as parameterizations applicable to both LOWTRAN and FASCODE models.

# A.1.1 Bolar Radiation

For practical purposes it is useful to categorize the extensive hierarchy of available computational procedures based on both the relative accuracy of the results required and the expenditure of computational resources incurred. A subjective evaluation according to these criteria results in four classes of method based on resultant accuracy characterized as either exact or approximate and computat' al methodologies denoted as either numerical or analytical. Exact methous are defined as those which agree among themselves to some acceptable degree of accuracy when applied to a variety of diverse problems. All other methods are approximate. The most recent intercomparison of exact methods suggests that about 1% accuracy in radiance can be expected (Lenoble, 1977). A variety of exact, numerical methods are listed in Table A-1 along with representative literature citations. The essential difference between numerical and analytical approaches is that the latter generally require less computer time. Analytical approaches are those which are generally implementable using simple algebraic relations supported by a priori specifiable parameters, i.e., there are no recurrent or iterative calculations and no convergence criteria. Exact analytical methods are available only for

Table A-l

Exact Numerical Multiple Scattering Computation Techniques

· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
Name	Representative References
Successive Orders of Scattering*	van de Hulst (1948) Irvine (1955) Nagel et al. (1978)
Gauss-Seidel	Herman and Browning (1965) Dave (1972)
Doubling and Adding	van de Hulst (1963, 1971) Hansen (1969a,h)
Monte Carlo*	Collins and Wells (1965) Plass and Kattawar (1968)
Discrete Ordinates	Chandrasekhar (1960) Liou (1973)
Spherical Harmonics*	Bergstrom and Viskanta (1972) Dave and Canosa (1974)
Invariant Imbedding	Bellman, Kalaba, and Wing (1960)
Variational-iterative <sup>†</sup>	Sze (1976) Burke and Sze (1977)

<sup>\*</sup>Represented in IAMAP Radiation Commission intercomparison, Lenoble, 1977)

 $<sup>^{\</sup>dagger}$ Isotropic scattering only

a few cases which are, unfortunately, not immediately applicable to general terrestrial radiance simulation situations. These cases include, for the most part, approaches based on Chandrasekhar's H functions for semi-infinite atmospheres ( $\tau = \infty$ ) and X and Y functions for finite atmospheres (Chandrasekhar, 1960). For the former set of problems, for example, solutions are available for isotropic, Rayleigh and various anisotropic phase functions. For finite atmospheres, solutions are available only for isotropic (Carlstedt and Mullikan, 1966) and Rayleigh scattering (Coulson et al., 1960). These exact treatments, often obtainable in the form of lookup tables, are useful as checks for the accuracy of both exact numerical methods and proposed approximate methods when applied to degenerate cases (such as isotropic scattering).

Approximate methods include those based on evaluating the first few tractable terms or orders of more extensive exact numerical treatments and those formulated specifically as approximations. In the former class of approximate methods, the philosophy is to accept the known risk of increased error for a specific application in order to benefit from reduced computer run time. Examples include terminating successive order of scattering approaches after a few scatterings (see Nagel et al., 1978), reducing the number of Legendre polynomials carried in the expansion of an angular scattering function, and limiting the number of quadrature angles in the discrete ordinate method. The method is approximate since the user knows a priori that the full available power of the exact numerical method at hand is not being exercised. For the simplest cases, these approaches often result in analytical solutions which may themselves be useful such as single and double scattering solutions (Deirmendjian, 1969; Hovenier, 1971), the two- and four-stream approximations based on the discrete ordinate method (Liou, 1973, 1974), and the two-step function approach based on general variational methods (Sze, 1976; Burke and Sze, 1977).

Multiple scattering methods formulated as intrinsically approximate have a common heritage in the estimation of radiation fluxes within larger numerical models (see Stephens, 1984). This applies both to the use of similarity relations to reduce anisotropic problems to isotropic equivalents (van de Hulst and Grossman, 1968) and various so-called two-stream approximations (Meader and Weaver, 1980). Notably, it is only recently that various investigators have sought approaches to treat the approximation of

multiply scattered radiances by augmenting a single scattering solution with an estimate of the multiply scattered radiance field based on a suitable flux parameterization. Included among these are: (a) the "diffuse field" approximation described by Bergstrom et al. (1981) for use in visibility impact models, (b) a path radiance approximation based on the delta-Eddington approach by Hering (1981) which was implemented within an operational visible contrast transmittance model, and (c) Kaufman's (1979) radiance approximation for applications to remote sensing. Kaufman has primarily applied his approximate scheme as a device to evaluate multiply scattered contributions to upward radiance within the context of multidimensional remote sensing (cf. Kaufman, 1982). Analogous solutions for downward radiance were derived by Isaacs (1981) for application to visibility model related radiance evaluation.

This overview of computational methods applicable to the simulation of radiances due to the multiple scattering of solar radiation suggests that a suitable parameterization may be found among one of the approximate approaches described above. In order to quantify this assessment, radiance comparisons were made between representative methods from each of the categories described above for a set of model atmospheres with aerosol content varying from ultraclear to hazy conditions. Table A-2 summarizes the scattering treatments selected in this comparison. The Gauss-Seidel multiple scattering (MS) approach was selected to provide exact numerical radiance results for reference purposes (Dave and Gazdag, 1970). The algorithm used (Dave, 1972) evaluates fluxes and radiances for atmospheres with arbitrary vertical distribution of anisotropic aerosol extinction overlying a Lambert reflecting surface. When applied to pure molecular scattering cases, radiance results from the code reproduce the exact analytical tabulations of Coulson et al. (1960) based on Chandrasekhar's X and Y functions for Rayleigh scattering to high accuracy.

Three parameterization approaches were investigated. These include: (a) single scattering (SS), (b) a stream approximation (SA), and (c) successive orders of scattering (SOS). The SOS method (which is presently solved numerically) was formulated to treat the single scattered radiance exactly and to approximate higher order scattering by an isotropic angular scattering function. These approaches are summarized in Table A-3. Results of the test case comparisons are discussed in Section A.2.

Table A-2

## Methods Selected for Intercomparison

		Co	Computational Effort				
ys to the second	Accuracy	Numerical	Analytical				
भूता स्थापना । स्वापना विकास स्थापना स्थापनी राष्		in the sign and the second of	The specific of the specific o	- <u>,</u> .			
2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Exact	Gauss-Seidel [MS] (Dave and Gazdag, Dave, 1972)					

Approximate

Successive Order of Scattering [SOS]

Single Scattering [SS]

Stream Approximation [SA] (Kaufman, 1979)

ころことでは個人の対象の対象を表示された。

\*Rayleigh scattering only

Summary of Source Function,

	Single Scattering (SS)	Stream Approximation (SA)	Successive Scatterings (SOS)
Source Function,	$\int_0^{\omega} = \frac{\omega}{4}  \text{r'e}$	$^{0}$ P( $\Omega_{1}$ , $-\Omega_{0}$ ) $J^{\pm} = J_{0} + \frac{\omega}{\pi} \{ k^{\pm} (1-\beta) \}$	$J^{n} = J_{0} + \frac{\omega}{2} \int_{0}^{\tau *} K(t, \tau) J^{n-1} dt$
	+ (1-w <sub>o</sub> ) B(0)	+	$K(t,\tau) = E_1( t-\tau ) + 2r E_2(\tau^{*-t})$
	<del></del>	7.2 <u>- 年</u> 7.3 12 12 12 14 12 2.3 1 1 12 14 14 14 14 14 14 14 14 14 14 14 14 14	+ E <sub>2</sub> (r*-r)

 $E_2(\tau^*-t) J(t) dt$  $+ (1-r) B(\theta_b)$ + (1-r) B(0<sub>b</sub>) + (1-r)  $B(\theta_b)$ Boundary Term J<sub>B</sub>

Radiance,

same

## A.1.2 Thermal Radiation

The detailed numerical schemes described in the previous section can be used to perform thermal radiation calculations by including the thermal emission term. For example, the doubling method has been extended by Wiscombe to include an inhomogeneous internal source (see Wiscombe, 1976 and the cited references for other detailed methods). Although these methods are useful for reference calculations, from practical considerations, the study of particle multiple scattering on atmospheric transmittance has to rely heavily on

Studies of the effects of aerosol multiple scattering on atmospheric infrared transmittance have emphasized the calculation of fluxes rather than radiances. The two-stream approach has been the commonly-used parameterization. In general, the two-stream approximation is a method of representing the radiation field in two streams in one-dimensional radiation transfer problems. The approximation, proposed by Schuster (1905) and Schwarzschild (1906), is to assume that the intensity in the positive direction is isotropic and that in the negative direction has a different value but is also isotropic. Chandra—sekhar (1960) has used the Gaussian quadrature to approximate the integral over angle, terming this the "discrete ordinate" method. The first approximation of the discrete ordinate method results in the same form as the Schuster—Schwarzschild approximation except for different constant coefficients due to Gaussian division.

Sagan and Pollack (1967) and Piotrowski (1956) compared the approximation with the exact solutions for the cases of conservative and non-conservative isotropic scattering. The results show 5-10% accuracy in absolute values. A survey paper by Irvine (1968) has investigated several approximation methods, including two-stream, Eddington and modified two-stream approximation. Uses of two-stream approximation for treating multiple scattering in thermal radiation are numerous (e.g., Rasool and Schneider, 1971; Wang and Domoto, 1974; Hansen et al., 1984). This parameterization has been used for climate application such as investigation of climatic effect due to aerosols (Hansen et al., 1980).

## A.2 Trade-off Analysis of Exact and Approximate Treatments

A series of computer codes was written to support an intercomparison of angle dependent radiances from single scattering (SS), stream approximation

(SA), and successive orders of scattering (SOS) parameterizations with those evaluated using accurate numerical multiple scattering treatments. For the stream approximation, two independent flux treatments were employed, one for solar radiation and one for thermal radiation. The intercomparison calculations were performed by parametrically varying the relevant optical properties of optical depth, single scattering albedo, and asymmetry factor. Thus, they were offline from either the LOWTRAN or FASCODE models. Furthermore, these calculations assumed single homogeneous scattering layers.

Assessment criteria include accuracy defined in terms of computer execution times for a set of test cases and accuracy measured by intercomparison with numerical results.

### A.2.1 Solar Scattering

For solar scattering, six model atmospheres were used in a comparison test consisting of one Rayleigh scattering case and five atmospheres including increasing amounts of aerosol. The vertical distribution of molecular density was that of the AFGL midlatitude summer model while that for the aerosol was Elterman's (1970) distribution. The turbidity weighting factor (defined as the ratio of total aerosol scattering optical depth to total scattering optical depth) varied from zero to near unity with corresponding surface visual ranges decreasing to about 1.2 km in haze. The optical properties of these model atmospheres are given in Table A-4. For each of the six test cases radiances were calculated using the SS, SOS, and SA methods at nine values of zenith angle, three values of azimuth angle, and two surface reflectances for both upward viewing from the surface and downward viewing from space (i.e., a total of 108 values). The solar zenith angle for all cases was 60°. Corresponding exact multiple scattering (MS) cases were evaluated using the Gauss-Seidel iterative method (Dave, 1972). The phase function used was based on the radiance values from the exact method, R(MS) and each approximate method [R(A), A=SS, SOS, SA], percent errors were calculated for the corresponding ith viewing angle, surface reflectance pair according to:

$$PE_{1}(A) = \left[\frac{R(MS) - R(A)}{R(MS)} \times 100^{\circ}\right]$$
 (A.1)

Table A-4

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Optical Properties of Model Atmospheres used in Solar Scattering Comparison Tests (A = 0.55 µm)

	00	Optical Thicknesses	esses			218116	
Model Atmosphere	Rayleigh	Aerosol Scattering	Rayleigh Scattering Absorption Total	Total	Turbidity Factor	Scattering Albedo	Kange (km)
Ravleigh	0.1	0.0	0.0	0.1	0.0	1.000	319.1*
Case 1	0.1	0.1220	0.0281	0.25	0.5494	0.8877	34.9
Case 2	0.1	6,3252	0.0749	0.50	0.7648	0.8502	14.0
	0.1	0.7317	0.1686	1.90	0.8798	0.8315	4.9
C 25 C	0.1	1.5446	0.3558	2.00	0.9392	0.82213	3.1
Case 5	0.1	3.9836	0.91767	5.00	0.97551	0.81651	1.2

\*Assuming no earth curvature effects and a Rayleigh scattering coefficient (for dry air at STP) of 0.01226 km (Goody, 1964, p. 414).

Additionally in order to provide a measure of overall accuracy for each case, root mean square errors, RMS, were evaluated for each approximate method, A, and surface reflectance, r, according to:

$$RMS(A,r) = \begin{pmatrix} 54 \\ 5 \\ 4 \\ 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \\ 2 \\ 1 \\ 4 \end{pmatrix} = \begin{pmatrix} 1/2 \\ 1/2 \\ 1/2 \end{pmatrix}$$
(A.2)

A comparison of RMS error according to Equ. (A.2) is summarized in Table A-5. For each of the approximations (single scattering, stream approximation, successive orders of scattering), RMS errors are provided for the six model atmospheres and two selected values of surface reflectance (r = 0.0, 0.4). The magnitude of RMS errors reported in Table A-5 for single scattering approximate those which would be obtained using the LOWTRAN6 single scattering option (IEMSCT = 2) for a like sun/observer geometry. Examining Table A-5, it is notable that the increase of RMS error with optical thickness is considerably less for the stream approximation and successive scattering method than for the single scatter parameterization. This is not surprising since the latter does not treat the multiply scattered radiance contribution which becomes increasingly important at larger optical thicknesses. At a moderate optical thickness (say 1.0, corresponding to an approximate visual range of 6.4 km) and zero surface reflectance the SOS and SA approaches are better by factors of about 1.5 and 2.0, respectively.

In order to provide a measure of efficiency for each approximation, execution times were tabulated for calculation of scattered radiances for the ensemble of eighteen upward and downward zenith angles, three azimuth angles, and two values of surface reflectance. These results are presented in Table A-6. The codes to evaluate each approximation were run on AER's Harris H800 and while not optimized for speed were configured for consistency with the layered atmosphere code structure of the LOWTRAN/FASCODE models. The exact multiple scattering (MS) execution times were obtained from comparison runs mad· on the AFGL CYBER. To provide a basis for comparison, Harris equivalent execution times (the values in parentheses) were estimated for each case using a benchmark execution of the Dave code from each machine to obtain a conversion factor of about 2.1. It is important to note that these times apply to the evaluation of the radiances from prespecified profiles of optical parameters and do not include time spent calculating atmospheric transmission.

Table A-5

Comparison RMS Errors for Single Scattering (SS),
Stream Approximation (SA), and Successive
Orders of Scattering (SOS)

•	cal Thickness		SS	SA	sos
0.10	(Rayleigh)	/0.0 /0.4	13.5 29.2	4.3 10.4	4.5 3.6
0.25	(Case 1)	/0.0 /0.4	33.4 41.8	12.2 4.9	17.9 18.8
0.50	(Case 2)	/0.0 /0.4	50.4 57.6	17.2 9.4	29.5 31.9
1.00	(Case 3)	/0.0 /0.4	67.0 72.5	29.1 23.2	43.3 48.6
2.00	(Case 4)	/0.0 /0.4	80.8 83.3	34.0 30.3	58.1 63.5
5.00	(Case 5)	/0.0 /0.4	90.0 90.5	39.1 40.1	73.1 73.7

It is interesting to compare execution times relative to the corresponding single scattering values. The stream approximation takes about two times longer regardless of optical thickness. This is of interest since the successive scattering execution times increase with increasing optical thickness and are at best eight times larger, although this could probably be shortened by careful optimization. Except for the Rayleigh case (which could be solved exactly anyway), multiple scattering execution times are at least an order of magnitude larger and increase slightly with optical thickness.

## A.2.2 Thermal Scattering

A set of model atmosphere test cases was employed to compare each multiple scattering parameterization for thermal scattering with an exact numerical treatment. Spectral regions of interest included the infrared where scattering by aerosol and cloud can be a factor in determining the radiance

Comparison Execution Times for Single Scattering (SS),
Stream Approximation of (SA), and Successive
Order of Scattering (SOS) Methods

Table A-6

		Execution	Time (sec)	
Optical Thickness	ss <sup>1</sup>	SA <sup>l</sup>	sos1	MS <sup>2,3</sup>
0.10 (Rayleigh)	3.4	7.8	27.4	2.45 (5.1)
0.25 (Case 1)	3.4	7.8	37.6	47.64 (100.1)
0.50 (Case 2)	3.4	7.8	47.6	48.79 (102.5)
1.00 (Case 3)	3.4	7.8	63.4	50.14 (105.3)
2.00 (Case 4)	3.4	7.8	90.6	51.98 (109.2)
5.00 (Case 5)	3.4	7.8	107.8	52.92 (111.13)

Harris H800 CPU time to evaluate radiances for eighteen upward and downward zenith angles, three azimuth angles and two values of surface reflectance, i.e., a total of 108 atmospheric paths.

<sup>&</sup>lt;sup>2</sup>AFGL CYBER CPU execution time in seconds for multiple scattering (Dave, 1975) solution of same 108 atmospheric paths.

<sup>&</sup>lt;sup>3</sup>Parentheses contain estimated Harris H800 execution times for comparison (the Rayleigh scattering case is actual) based on an H800/CYBER time factor of 2.1 obtained from a common benchmark run of the Dave code.

field and the microwave/millimeter wave where scattering is due largely to precipitation. Calculations were performed for similar sets of optical properties for the stream approximation (SA), successive orders of scattering (SOS), and an accurate numerical method for multiple scattering, the discrete ordinate method (DOM).

In order to maximize the effects of aerosol scattering in the infrared, a spectral region was selected (900 cm-1) where gaseous absorption is relatively weak. This window region, influenced primarily by water vapor continuum absorption, is used for remote sensing purposes such as surface temperature retrieval. The test comparisons were done parametrically with optical thicknesses in the range from 0.05 to 1.00, single scattering albedos between 0.5 and 0.9, and asymmetry factors between 0.6 and 0.8. These ranges were chosen both to include values representative of the 10-12 um window for typical haze conditions and to push the effect of scattering to unrealistically high values for testing purposes. The optical properties of the model atmospheres used in the thermal scattering comparison are summarized in Table A-7.

Table A-7

Optical Properties of Model Atmospheres
Used in Thermal Scattering Comparison

	Optical Thickness	Single Scattering Albedo	Asymmetry Factor
Infrared Region (v	$= 900 \text{ cm}^{-1}$ )		
Case 1 a,b	0.05	0.50, 0.75, 0.90	0.6, 0.7, 0.8
Case 2 a,b	0.25	0.50, 0.75, 0.90	0.6, 0.7, 0.8
Case 3 a,h	0.50	0.50, 0.75, 0.90	0.6, 0.7, 0.8
Case 4 a,b	1.00	0.50, 0.75, 0.90	0.6, 0.7, 0.8
Microwave/millime	ter wave (f = 1	9.35, 37.00 GHz)	
Case 5 a,b (19.35	GHz) 0.906	0.21 (M-P, Rain rate 15 mmhr <sup>-1</sup>	Phase Function)
Case 6 a,b (37.00	GHz) 3.20	0.39 (M-P, Rain rate 15 mmhs <sup>-1</sup>	Phase Function

a: lsothermal  $T_S = 288K$ ,  $T_a = 283K$ 

b: Gradient  $T_S = 286K$ ,  $\overline{T}_g = 283K$ 

The surface temperature for all calculations was assumed to be 288 K. Two types of atmospheric temperature profile were investigated: an isothermal atmosphere with a temperature of 283 K and an atmosphere with a 10 K temperature gradient from top to bottom and a mean temperature of 283 K. These are called the isothermal and gradient atmospheres, respectively.

Microwave/millimeter wave calculations were done for cases with similar surface temperatures and temperature profiles. Two frequencies, 19.35 and 37.0 GHz (1.55 and 0.81 cm, respectively) corresponding to those used for satellite remote sensing were investigated. For these cases (see Table A-7), scattering was assumed due to a Marshall-Palmer distribution of rain with a rain rate of 15 mm/h. Precipitation scattering properties such as the extinction coefficient, single scattering albedo, and angular scattering fuction were evaluated from a parameterization of the Mie theory calculations of Savage (1978) developed for a millimeter wave simulation model (Isaacs et al., 1985).

The discrete ordinate method (DOM) (Liou, 1973) provided numerical solutions as a standard for comparison. A sixteen stream version of the DOM code was used. Radiance results were thus given at eight urward and eight downward zenith angles within the domains from 0 to 90 degrees (upward radiance) and 90 to 180 degrees (downward radiance). The endpoints of these ranges (i.e., 0, 90, and 180 degrees) are extrapolated from internal points and are thus not accurate values. To facilitate calculation of the required Legendre polynomial expansion of the angular scattering function, Henyey-Greenstein phase functions with the desired asymmetry factors were employed.

Results of the multiple scattering parameterization intercomparison were tabulated as radiances, percent errors as a function of zenith angle, and percent root mean squared (RMS) errors. The latter quantity was evaluated over all zenith angles used in the intercomparison. Sample results are shown in Figures A-1 to A-4. Figure A-1(a) and (b) illustrate the comparison between upward and downward emergent radiances, respectively, for the SA and SOS parameterizations and the exact DOM solution. This particular calculation is for an optical depth of 0.25, single scattering albedo of 0.9, and an asymmetry factor of 0.8. The SOS approach underestimates upward radiance and overestimates downward radiance compared to the DOM due to the assumption of isotropic scattering. The SA, however, reasonably reproduces the multiply scattered radiance field, except near the horizon (zenith angles approaching 90°).

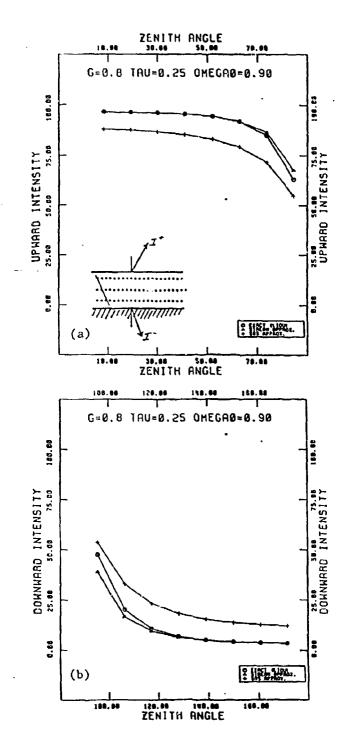


Figure A-1. Comparison of emergent radiances from DOM, SA, and SOS for g=0.8,  $\tau=0.25$ ,  $\omega_0=0.9$ : (a) upward radiances, (b) downward radiances (units: erg sec<sup>-1</sup> cm<sup>-1</sup> str<sup>-1</sup> (cm<sup>-1</sup>)<sup>-1</sup>)

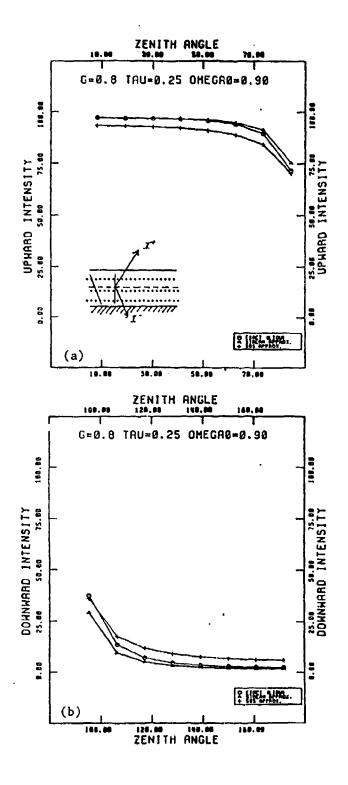


Figure A-2. Comparison of internal radiances from DOM, SA, and SOS for g=0.8,  $\tau=0.25$ ,  $\omega_0=0.9$ : (a) upward radiances, (b) downward radiances (units: erg sec<sup>-1</sup> cm<sup>-1</sup> str<sup>-1</sup> (cm<sup>-1</sup>)<sup>-1</sup>)

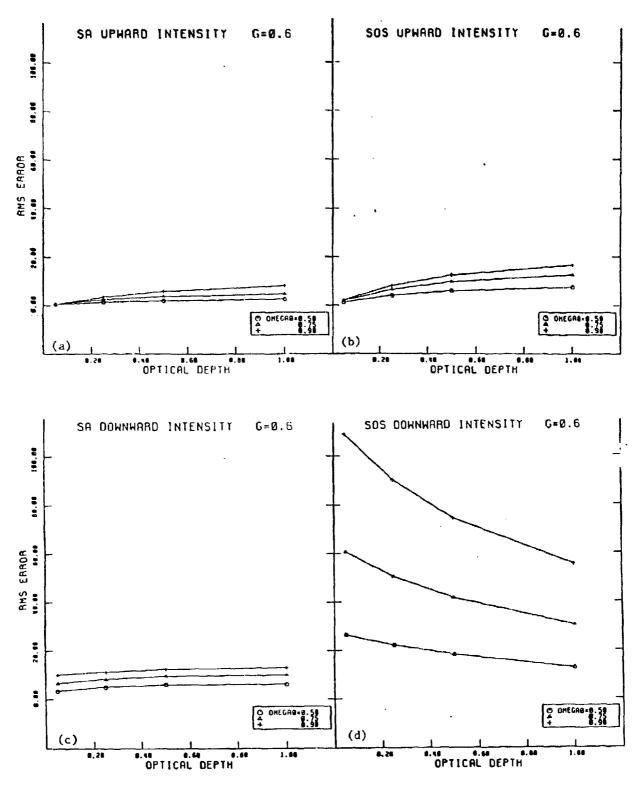


Figure A-3. Percent RMS erros for SA and SOS compared to DOM as a function of optical depth and single scattering albedo for g = 0.6:
(a) SA upward radiance, (b) SOS upward radiance, (c) SA downward radiance, and (d) SOS downward radiance.

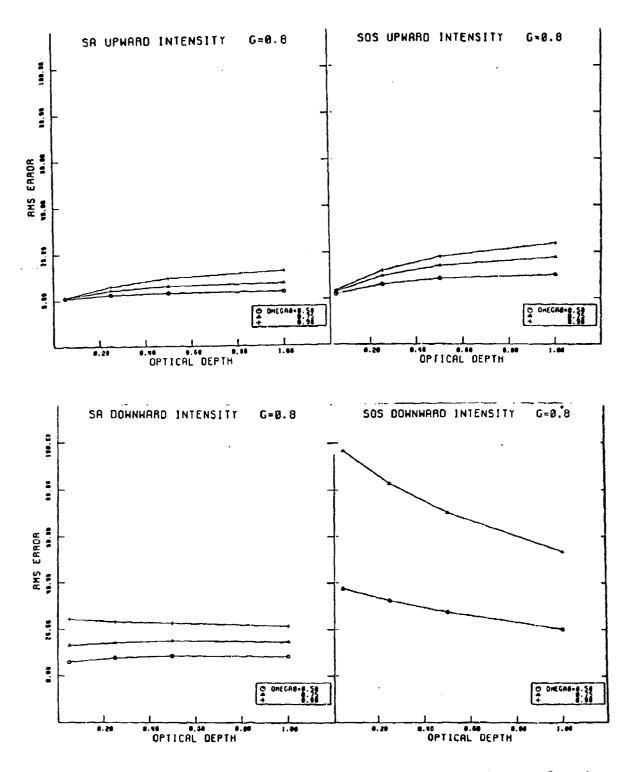


Figure A-4. Percent RMS erros for SA and SOS compared to DOM as a function of optical depth and single scattering albedo for g = 0.8:

(a) SA upward radiance, (b) SOS upward radiance, (c) SA downward radiance, and (d) SOS downward radiance.

Similar conclusions can be drawn by looking at the internal upward and downward radiances halfway through the layer at an optical depth of 0.125 (Figures A-2(a) and (b), respectively).

Figures A-3 and A-4 illustrate the percent RMS error for the stream approximation and successive orders of scattering compared to the discrete ordinate solutions for all optical depths, and single scattering albedos, and scattering asymmetry factors of 0.6 and 0.8, respectively. While the SOS approach provides reasonable upward radiances with errors only slightly greater than the SA, SOS derived downward radiances are quite inaccurate. Downward radiances are a real test of the scattering parameterization since upward radiances are largely determined by the uniform surface emission at these optical depths. Notably, RMS errors for the stream approximation are weakly dependent on optical depth and are at most about 25 percent. Errors are largest for high single scattering albedo and asymmetry factor, i.e., when the scattering effect is maximum and when the angular scattering function is strongly forward scattering. This is expected due to the nature of the approximation wased.

Computer execution times were also tabulated for each thermal scattering test case ensemble to ascertain their relative efficiency. Execution times are given in Table A-8. Times for the SOS and DOM are comparable while the SA was about 40 times faster than the DOM. These results suggest that the SA is the candidate parameterization of choice.

## A.3 Recommendations for LOWTRAN and FASCODE

Based on these results, the stream approximation was selected for implementation for thermal scattering as well as solar scattering in the LOWTRAN and FASCODE models. Based on the evaluation and consideration of the requirements of efficiency, accuracy and code structure of LOWTRAN and FASCODE models, the parameterization of the stream approximation together with the correlated-k approximation is best suited for implementation into these models. The parameterization is unique in the sense that the correlated-k approximation decouples the multiple scattering from the treatment of nongray

Table A-8
Thermal Results

Execution Time (sec) Optical Thickness	SA	sos	DOM (Liou)*
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Tau = 0.05	The state of the s		
$(g = 0.6, \omega_0 = 0.50)$ (12.10)	.35	6.28	5.76
(12.10)	.35	- <u>-</u> 6.28	- <del>- 5</del> ,79
Tau = 0.25	STEEL STEEL		·
$g = 0.6, \omega_0 = 0.50$	.34	7.55	5.79
$(g = 0.6, \omega_0 = 0.90)$	.34	10.17	5.81
THE STATE OF THE S	The second secon		্রাক্তর শুন্ত ক্রিয়াল ক্রা জের জারাক্ত
$Tau = 0.50$ $Tau = 0.6$ , $\omega_0 = 0.50$	.34	8.87	5.72
(g = 0.6, ω <sub>0</sub> = 0.90)	.34	12.79	5.79
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$(g = 0.6, \omega_0 = 0.50)$	.34 (12.06)	10.14	5.74
(g = 0.6, ω <sub>0</sub> = 0.90)	.36 (12.22)	16.69	5.82

Runs were made on AFGL's Cyber 750 system. All other runs on AER's Harris are Harris equivalents for runs made on the Cyber, using a benchmark factor of 2.1.

gaseous absorption so that the stream approximation can be used to treat multiple scattering in both the LOWTRAN and FASCODE models. The stream approximation is extremely attractive since it retains the analytical simplicity (and hence, efficiency) of single scattering while improving the treatment of multiple-scattering (and hence, accuracy).

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# Appendix B EXAMPLE OF FASCODE OUTPUT

A case is included as a test for FASCODE with multiple scattering. The input cards for the case are listed in Table B-1 and the listing of the file TAPE 6 is in Table B-2. The next section will discuss the output for the test case. Only those details which differ from the standard FASCODE output will be discussed.

This case demonstrates the new multiple scattering calculation for thermal scattering of downward radiance. The parameters selected for this case are as follows: the atmospheric profile is the 1962 U.S. Standard and the boundary layer aerosol model is RURAL with 5 km meteorological range. The path is a slant path from the ground to 20 km with a zenith angle at the ground of 0.0 degrees.

The output for this case shown in Table B-2 will now be described. The first difference is in CARD 2, which now contains another quantity, IMS. IMS—is the eleventh variable printed on CARD 2, and is the flag for multiple scattering. When IMS is 1, the multiple scattering features of the program will be used. The next difference which occurs in the output, is a print of the path parameters which occurs on pages 2 and 3. This occurs due to a call to FSCGEO which is needed to determine whether or not the user defined path starts at or intersects the ground, and whether or not HMINMS and HMAXMS are contained within the user defined path. (This is explained further in the user instructions in Section 3.1.4. If additional paths were determined to be necessary in order to accommodate the multiple scattering calculation, these paths would be run and the corresponding output would appear in the calculations at this point. The user defined path would be the last path that would appear in the output.)

The next 25 pages in the output shown in Table B-2 are identical to those in the output for a run without multiple scattering. The following 21 pages which output the optical depths, radiance, and transmittance for each FASCODE layer are different for the multiple scattering runs. The differences will be discussed for one layer, since each layer has the same output. The first difference is that the radiance that is printed is the thermal emission and not the conservative scattering radiance supplied with the standard FASCODE

run. The second difference is that after the radiance and transmittance is printed, the composite upward flux and reflectance for that layer is also printed. These quantities are intermediate results used by the multiple scattering sections of the code, and are printed for the users benefit to see what the multiple scattering is doing.

That would conclude the output for the standard PASCODE run, but for the multiple scattering run, we still need to add the fluxes from the top down in order to determine the multiple scattered contribution. The next 21 pages are printout from the downward adding of the fluxes. The first page starts off with the composite downward flux and reflectance for layer 10. Then the total upward and downward flux for the top of layer 10 is printed. The next page prints out the composite downward flux and reflectance for layer 9. Then the total upward and downward flux for the top of layer 9 is printed. The next page starts with the output of the source function for the multiple scattering contribution to the radiance from Layer 10 (this quantity is actually the MS memission from layer 10). This is followed by the composite downward flux and reflectance for layer 8, followed by the total upward and downward flux for the top of layer 8. The source function for layer 9 appears at the top of the next page, and is followed by the total multiple scattered emission from both layer 9 and 10. This output scheme is continued such that on the last of the 21 pages the final MS emission that is printed is the total multiple scattering emission for the path.

The next and final page in the output is the total radiance for the FASCODE run and consists of the multiple scattered emission added to the thermal emission.

TABLE B-1

## INPUT CARDS FOR THE FASCODE TEST CASE

Test Case

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TABLE 8-2

# FASCODE OUTPUT FOR CASE 1

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-	AER1-RH	<u>:</u>	1.536E+#1 3.778E+#1	3.231E+08 .808E+88	. BBBE+BB	. 888E+08	. 883E + 88	. BBBE+8B . BBBE+8B	. 000E + 00	. 868E + 58	. 888 8 E + 88	. 883E+88	. 888 E + 88	. 888E + 98	. 888E+88	. 888E+88	. 888E+88 . 888E+88 . 888E+88	888E+38
	AEROSOL 4	Ĵ	.888E+88 3	.888E+88 3	. 888E + 88 . 880E + 88	. 888E+88	. 8885 + 88	. BBBE+BB . BBBE+BB	. 808E+88	. 888E+88	. 838E+188	. 838E+138	. 888E+88	. 888E+88 . 888E+83	. 888E+88 . 888E+88	. 888E+88 . 888E+88	2.333E-05 1.640E-05 1.145E-05	7.998E-86
	AEROSOL 3	:	. BBBE+BB . BBBE+BB	. 388E+88	. 488E + 89	. 8885+88 . 8885+38	. 000E+88	. 888E+65	5.178E-84	4.428E-04 3.958E-84	3.820E-04 4.250E-04	5.288E-84 5.818E-84	5.898E-84 5.828E-84	4.200E-04 3.000E-04	1.988E-84 1.318E-84	6.595E~#5 3.32#E-#5	. 888E+98 . 888E+98 . 688E+88	. 808E+BB
	AEROSOL 2	<u>:</u>	. BBBE+88	.8886+88 3.468E-82	1.858E-02 9.316E-03	7.710E-83 6.230E-93	3.370E-03 1.8.0E-03	1.140E-03	. 885E+08	. 888E+88	. 880E+00	. BBFE+BB	. 888E+88	BBBE+BB	. 889E+88	. 888E+88	. 888E + 88 . 888E + 88 . 888E + 88	. BBBE+BB
	AEROSOL 1	<u>:</u>	7.788E-81 7.788E-81	6.218E-02	. 888E + 118 . 888E + 118	. 888E+38	. BOBE + 38	. 888E+38	. 028E+88	. 888E+88	. 883E +88	. 888E+88	. 888E + 88	. 888E + 88	. BBFE + BB . BBBE + BB	. 000E + 00	. 8886 + 88 . 8886 + 88 . 8886 + 88	. GBBE+BB
	EGNH	ATH CH/KH	. 888E+88	. 888E + 88	. 880E+88	. 888E + 88	. BBBE+OB	. BBBE+38	. 888E+88	. 888E+88	. 888E + 88	. 888E+88	. 888E+88	. 888E+88	. 868E+88	. 808E+08	. 888E+88 . 888E+88 . 888C+88	. 800E+88
	CATAFAM	HOL/CM2 KM /	. 888E+88	. 888E+88	. 000E+00	. 888E+88	. 000E+00	. 838E+88	. 8085+88	. 888E+88	. 0885 - 80	. AUBE+BB . BBBE+BB . BBBE+BB	BBBE+BB					
	<b>-</b>	3	288.2	275.2	262.2	249.2	236.2	223.3	216.7	216.7	216.7	216.7	216.7	218.6	22B.6 221.6	224.8	231.4 236.5 243.4	250.4
	•	( MB)	1813.888 898.888	795.888	616.63B 540.503	472.288 411.188	356.5AR 388.8RB	265.000 227.000	194.808 165.808	141.700	183.588 89.588	75.65B 64.67B	55.29# 47.29#	46.478	29.72B 25.49B	17.468	8.293 5.746 4.862	2.871
	2	C K	1.88	2.88 3.88	4.00 5.00	6.88	8.89.6. 89.6.	12.88	12.88	14.88 15.88	16.88	18.68 19.68	20.88 21.88	22.88 23.88	24.88	27.50 30.88	32.58 35.98 37.50	48.83
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CONTROL CARD 2.1 PARAMETERS WITH DEFAULTS:

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MODEL ITVDEL IBMAN NOZERO NOPRRT IPUNCH	RE HSPACE VBAR

SLANT PATH SELECTED. ITYPE .

CONTROL CARD 2.2: SLANT PATH PARAMETERS

TABLE B-2 (Cont.)

		20	5.336+18	4.82E+18 4.38E+18 3.95E+18	3.56E+18 3.20E+18 2.87E+18	2.57E+18 2.29E+18 2.83E+18	1.898+18 1.598+18 1.358+15	1.16F+18 9.98E+17 8.46E+17	7.24E+17 6.19E+17 5.29E+17	4.52E+17 3.86E+17 3.29E+17	2.39E+17 2.39E+17 2.04E+17	1.74E+17 1.18E+17 8.00E+16	5.28E+16 3.63E+16 2.59E+16	1.74E+16 1.21E+16 9.55E+15	6.18E+15 4.46E+15 2.47E+15	1.34E+15 7.88E+14 3.68E+14	1.74E+14 8.81E+13 3.58E+13
		CH4	4.33E+13	3.93£+13 3.56E+13 3.21E+13	2.9ØE+13 2.5ØE+13 2.33E+13	2.89E+13 1.86E+13 1.65E+13	1.45E+13 1.27E+13 1.08E+13	9.12E+12 7.71E+12 6.58E+12	5.48E+12 4.6ØE+12 3.85E+12	3.28E+12 2.53E+12 2.13E+12	1.71E+12 1.36E+12 1.89E+12	8.88E+11 5.57E+11 3.58E+11	2.09E+11 1.31E+11 8.19E+10	4.69E+18 2.68E+18 1.49E+18	8.18E+89 4.49E+89 1.95E+89	8.38E+R8 3.5AE+R3 1.42E+P3	5.498.87 2.018.97 7.198.06
		8	3.826+12	3.35E+12 2.93E+12 2.55E+12	2.22€+12 1.99€+12 1.78€+13	1.54E+12 1.31E+12 1.87E+12	8.60E+11 6.83E+11 5.19E+11	3.60E+11 2.37E+11 1.62E+11	1.84E+11 7.48E+18 5.86E+18	3.24E+18 2.48E+18 1.89E+18	1.51E+10 1.49E+10 1.37E+10	1.33E+18 1.82E+18 7.66E+89	5.72E+09 4.49E+09 3.59E+09	4.99E+09 5.16E+09 5.39E+09	5.71E+09 6.19E+09 5.32E+09	4.50E+89 4.48E+89 4.31E+09	2.86E+09 1.88E+09 1.17E+09
	STS C14-31	N20	8.15E+12	7.48E+12 6.78E+12 6.85E+12	5.45E+12 4.9RE+12 4.39E+12	3.90E+12 3.5E+12 3.118+12	2.73E+12 2.38E+12 2.81E+12	1.69E+12 1.42E+12 1.19E+12	9.96E+11 8.24E+11 6.76E+11	5,47E:11 4,37E+11 3,46E+11	2.75E+11 2.25E+11 1.83E+11	1.46E+11 8.96E+1Ø 5.42E+1Ø	2.94E+18 1.63E+18 8.29E+89	3.75E+Ø9 1.6ØE+Ø9 6.51E+Ø8	2.74E+88 1.82E+88 2.23E+87	4.52E+06 8.54E+05 1.54E+05	2.62E+84 4.22E+83 6.68E+82
	NSITY (MOL	03	6.78E+11	6.78E+11 6.78E+11 6.27E+11	5.77E+11 5.77E+11 5.65E+11	6.15E+11 6.53E+11 8.91E+11	1.13E+12 1.63E+12 2.01E+12	2.13E+12 2.38E+12 2.63E+12	3.81E+12 3.51E+12 4.02E+12	4.39E+12 4.77E+12 4.77E+12	4.89E+12 4.77E+12 4.52E+12	4.27E+12 3.27E+12 2.51E+12	1.86E+12 1.38E+12 9.66E+11	6.07E+11 3.5ØE+11 2.15E+11	1.28E+11 6.62E+18 7.13E+18	7.07E+89 2.37E+89 5.17E+88	2.89E+88 1.;5E+88 8.55E+07
1976	DE	<b>200</b>	8.416+15	7.63E+15 6.91E+15 6.24E+15	5.62E+15 5.06E+15 4.53E+15	4.055+15 3.616+15 3.216+15	2.84E+15 2.50E+15 2.14E+15	1.83E+15 1.56E+15 1.34E+15	1,14E+15 9,77E+14 8,35E+14	7.14E+14 6.18E+14 5.28E+14	4.43E+14 3.78E+14 3.22E+14	2.75E+14 1.86E+14 1.26E+14	8.33E+13 5.81E+13 4.Ø9E+13	2.74E+13 1.91E+13 1.35E+13	9.64E+12 7.05E+12 3.98E+12	2,12E+12 1,12E	2.75E+11 1.26E+11 5.65E+10
STANDARD.		H28	1.97E+17	1.48E+17 9.78E+16 6.82E+16	3.68E+16 2.14E+16 1.27E+16	7.028+15 4.016+15 1.54E+15	6.02E+14 2.74E+14 1.24E+14	6.02E+13 2.81E+13 2.03E+13	1.37E+13 1.14E+13 9.68E+12	8.33E+12 7.21E+12 6.26E+12	5.465+12 4.88E+12 4.28E+12	3.69E+12 2.58E+12 1.81E+12	1.22E+12 8.63E+11 6.13E+11	4.18E+11 2.99E+11 2.14E+11	1.53E+11 1.12E+11 6.872E+18	3.05E+18 1.45E+10 6.03E+09	2.36E+09 7.86E+08 2.28E+08
U. S. S		AIR	2.556+19	2.31E+19 2.895+19 1.89E+19	1.70E+19 1.53E+19 1.37E+19	1.23E+19 1.09E+19 9.71E+18	8.60E+19 7.58E+18 5.48E+18	5.54E+18 4.74E+18 4.Ø5E+18	3.46E+18 2.96E+18 2.53E+18	2.168+18 1.85E+18 1.57E+18	1.34E+18 1.14E+18 9.76E+17	8.33E+17 5.64E+17 3.83E+17	2.52E+17 1.76E+17 1.24E+17	8.30E+16 5.80E+16 4.89E+16	2.92E+16 2.13E+16 1.18E+16	6.42E+15 3.38E+15 1.72E+15	8.348+14 3.838+14 1.71E+14
9	REFRACT		27:.94	246.92 223.62 282.85	182.11 163.71 146.76	131.28 116.91 183.87	91.93 81.11 59.35	59.27 50.65 43.29	37.88 31.64 27.84	23.12 19.76 16.83	14.34 12.23 18.44	8.91 6.03 4.03	2.78 1.88 1.32	8. 6.54.	.31	. 82	83° 80°
PED IS: M	<b>-</b>	ŝ	288.26	281.78 275.28 268.78	262.28 255.78 249.28	212.78 236.28 229.78	223.38 2:6.88 2:6.78	2:5.78 216.78 216.78	216.78 215.78 216.78	216.78 216.78 217.68	218.68 219.68 228.68	221.68 224.88 226.58	230.00 236.50 242.90	250.40 257.30 264.20	270.68 270.70 262.88	247.98 233.38 219.68	208.40 :98.60 :85.90
OFILE SELECT	α.	( жв.)	1613.86886	898,60000 795,00000 701,20000	616.50000 540.53000 472.20020	411.16686 356.58886 388.8888	265.80080 227.80880 194.80888	165.88888 141.78888 121.18888	. #3.50000 88.50000 75.65000	64 67888 55.29888 47.29888	48.47888 34.67888 29.72888	25.49888 17.43888 11.97888	8.21928 5.74620 4.15203	2.87183 2.86648 1.49188	1.89888 1.99788 1.2558	.21900 .10990 .85238	. 02478 .01856 .88446
PHERIC PRO	2	(K)	999	1.000 2.000 3.000	4.888 5.688 6.888	7.000 8.002 9.008	18.888 11.888	13.000 14.000 15.000	16.020 17.000 18.000	19.988 20.889 21.888	22.000 23.000 24.000	25.888 27.588 38.888	32.500 35.000 37.500	48.088 42.588 45.083	47.500 50.000 55.000	60.000 65.000 70.000	75.000 80.000 85.000
AT-40SF	-		-	t1m. <b>4</b>	887	ယက္	-225	1.5	1.000	22 23	23 24 25	11.00	3.29	333 4334	36.5	38 39 43	# # # # C. C.

# TABLE B-2 (Cont.)

1.49E+13 6.08E+12 2.38E+12											
2.48E+86 7.85E+85 2.55E+25											
7.14E+#8 3.99E+98 1.25E+88						TEMP DIFF (K)	e. e.	တာတာတာ လ လာတာတာလ လာတာတာလ	2.7 3.9 15.6	11.3	6.00 6.00 6.00 6.00 8.00 8.00 8.00 8.00
7 9.64E+#17 1.38E+#16 1.97E+#18						VOIGT RATIO	1.18	1.19	1.098 1.098 1.098 1.098	1.15	1.80 1.80 1.80 1.60 1.60 1.60
18 5.88E+8 89 2.85E+8 89 4.76E+8			AUTLAY ATE			VOIGT (CM-1)	.18133	.87264 .86893 .85888 .84262	. #2771 . #14#1 . #171# . ##35# . ##17#	. 68119 . 68184 . 88697 . 88889	.00086 .00083 .00081 .00078
07 2.35E+ 07 9.65E+ 26 3.92E+			ROUTINE	JDTHS · KM · KM H AT STP	1GHT	ZETA	. 991 1999.	9886	0.0000 0.0000 0.0000 0.0000	. 284 . 1984 . 1988	1815 1815 1818 1818 1818
+13 6.87E+ +13 1.58E+ +13 4.84E1			C LAYERING FY THEM IF	F VOIGT WEET AT BE	CULA TUMBE	OPPLER (CM-1)	88892 88888	88889 8889 8885 8888 8888	00080 00080 00088 00088 00081	8883 8885 88887 88887	66685 66883 66888 66678
.86 2.92E			AUTOMATI	K RAT TEMI	AVERAGE MOLE	ORENTZ DO	10132 .	87263	62768 61397 66781 6674	88861 88834 88019	
6.98 8.48 5.18	ARD FORM	77007 77007 00	CED BY TH Boundarie	SED:	CM-1 * A	⊢2 1	88.29 78.45	58.78 58.95 39.45	19.48 16.78 16.70 20.68	237.27 248.68 .1 268.86 .1	23.85 23.85 27.97 24.33
18184 18 18876 19 18832 19	, ANGLE IN STANDA	. 8666 28. 888 . 888. 888 188. 888	IES PROD	ERS ARE U 2.00 10.00 15.30	36.80 945.80	. (8)	.80808 2	.299889 .29741 .29741 .207883 .377.983	49918 169918 74878 772668 52214	.52596 2 .13644 2 .81614 2	
9. 67 E	N HI, HZ RAMETERS		BOUND LD EXA	PARAME AT F1 F2 R0	<u> </u>	σ. <u>°</u>	Ø 1613 Ø 845	7 701 0 577 0 577 0 380 0 90	241.4 100 101.1 100 25.7 12.55	es es es es es es es es es es es es es e	ರ <i>ಾರರ</i>
96.888 95.888 188.888	2A: GIVE PATH PA	H1 H2 ANGL PH1 HM1N	E LAYE ER SHO	01.001106 AVTR T018 ALZE	AVMUT	2 (KH)	1.50	6.40.7 80.7 80.80.80	18.68 19.88 19.48 24.88	335.38 839.38 83.53 88.53 89.53	66.20 64.86 69.58 75.38
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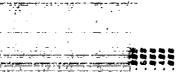
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\*\*\*\*\*PROGRAM FSCATM\*\*\*\*

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SLANT PATH SELECTED, ITYPE .

CONTROL CARD 2.2: SLANT PATH PARAMETERS

TABLE B-2 (Cont.)

		20	5.336+18	4.83E+18 4.38E+18 3.95E+18	3.56E+18 3.28E+18 2.87E+18	2.57E+18 2.29E+18 2.03E+18	1.88E+18 1.59E+18 1.36E+18	1.16E+18 9.98E+17 8.46E+17	7.24E+17 6.19E+17 5.29E+17	4.526+17 3.866+17 3.296+17	2.88E+17 2.39E+17 2.04E+17	1.74E+17 1.18E+17 8.00E+16	5.28E+16 3.68E+16 2.59E+16	1.74E+16 1.71E-16 8.55E+15	6.186+15 4.466+15 2.476+15	1.34E+15 7.08E+14 3.6#E+14	1.74E+14 8.@1E+13 3.58E+13
		CH4	4.33E+13	3.93E+13 3.56E+13 3.21E+13	2.98E+13 2.68E+13 2.33E+13	2.89E+13 1.86E+13 1.65E+13	1.45E+13 1.27E+13 1.#8E+13	9.12E+12 7.71E+12 6.5BE+12	5.48E+12 4.6FE+12 3.85E+12	3.2#E+12 2.63E+12 2.13E+12	1.71E+12 1.36E+12 1.89E+12	8.88E+11 5.57E+11 3.58E+11	2.89E+11 1.31E+11 8.19E+18	4.69E+10 2.68E+10 1.43E+14	8.18E+#9 4.49E+#9 1.95E+#9	8.38E+#8 3.5#E+#8 1.42E+#8	5.49E+07 2.81E+07 7.18E+66
		8	3.828+12	3.35E+12 2.93E+12 2.55E+12	2.226.12 1.992.12	1.54E+12 1.31E+12 1.87E+12	8.68E+11 6.83E+11 5.19E+11	3.6AE+11 2.37E+11 1.52E+11	7.48E+11 7.48E+18 5.86C+18	3.24E+18 2.48E+18 1.89E+18	1.61E+1.8 1.49E+1.8 1.37E+1.8	1.33E+18 1.62E+18 7.66E+89	5.72E.09	4.99E+#9 5.16E+#9 5.39E+#9	5.71£+#9 6.19£+#9 5.32£+#9	4.58E+89 4.48E+89 4.31E+99	2.86E+#9 1.8FE+#9
	S CM-3)	N20	8.15E+12 3	7.48E+12 6.78E+12 6.85E+12	5.45E+12 2 4.98E+12 1	3.93E+12 3.58E+12 3.11E+12	2.73E+12 2.38E+12 2.81E+12	1.69E+12 1.42E+12 1.19E+12	9.96E+11 8.24E+11 6.76E+11	S.47E+11 4.37E+11 3.46E+11	2.75E+11 1 2.25E+11 1 1.83E+11 1	1.46E+11 1 8.96E+18 1 5.42E+18	2.94E+1.8 1.63E+18 8.29E+89	3.75E+#9 1.69E+#9 6.51E+#8	2.74E+88 1.82E+88 2.23E+87	4.52E+86 8.54E+85 1.54E+85	2.62E+#4 4.22E+#3 6.68E+#3
	TA CHOI	03	786+11	6.78E+11 6.27E+11 6	. 776+11 . 776+11 . 656+11	6.15E+11 6.53E+11 8.91E+11	1.13E+12 1.63E+12 2.81E+12	2.13E+12 2.38E+12 2.63E+12	3.81E+12 3.51E+12 4.02E+12	4.39E+12 4.77E+12 4.77E+12	4.89E+12	1.27E+12 3.27E+12 2.51E+12	1.86E+12 :	6.67E+11 3.68E+11 2.15E+11	1.28E+11 5.62E+14	7.87E+89 2.37E+89 5.17E+88	2.89E+88 1.15E+88 8.56E+87
976	DENS	C02	8.412+15 6	7.63E+15 6 6.91E+15 6	5.62E+15.5 5.86E+15.5 4.53E+15.5	4.05E+15 6 3.61E+15 6 3.21E+15 8	2.58E+15 1 2.58E+15 1 2.14E+15 2	1.83E+15 2 1.56E+15 2 1.34E+15 2	1.14E+15 3 9.77E+14 3 8.35E+14 4	7.14E+14 4 6.19E+14 4 5.20E+14 4	3.78E+14 3.22E+14	2.75E+14 1.86E+14 1.26E+14	8.33£+13 1 5.81£+13 1 4.#9£+13 5	2.74E+13 6 1.91E+13 1.35E+13	9.64E+12   7.85E+12   3.90E+12	2.12E+12 1.12E+12 5.69E+11	2.75E+11 2 1.26E+11 1 5.65E+10 8
TANDARD, 1		#2#	1.976.17	1.48E+17 9.78E+15 6.82E+15	3.68E+15 2.14E+13 1.27E+15	7.82E+15 4.P1E+15 1.54E+15	6.82E+14 2.74E+14 1.24E+14	5.#26+13 2.816+13 2.#36+13	1.37E+13 1.14E+13 9.68E+12	8.33E+12 7.21E+12 6.26E+12	5.46E+12 4.8ØE+12 4.2%E+12	3.69E+12 2.59E+12 1.81E+12	1.22E+12 8.63E+11 6.13E+11	4.186+11 2.996+11 2.146+11	1.53E+11 1.12E+1! 6.83E+1#	3.85E+1# 1.42E+1# 6.83E+89	2.35E+89 7.86E+88 2.28E+88
U. S. ST		AIR	2.55€+19	2.31E+19 2.#96+19 1.89E+19	1.53E+19 1.37E+19	1.23E+19 1.89E+19 9.71E+18	8.58E+18 7.58E+18 6.48E+18	5.54E+18 4.74E+18 4.#5E+18	3.46E+18 2.96E+18 7.53E+18	2.16E+18 1.85E+18 1.57E+18	1.34£+18 1.14E+18 9.76E+17	8.33E+17 5.64E+17 3.83E+17	2.52E+17 1.76E+17 1.24E+17	8.32E+16 5.82E+16 4.89E+16	2.926+16 2.13E+16 1.18E+16	6.42E+15 3.38E+15 1.72E+15	8.34E+14 3.83E+14 1.7(F+14
HERIC PROFILE SELECTED 15: M - 6	REFRACT	1.856	271.94	246.92 223.62 282.85	:82.11 163.71 146.76	131.2# 116.91 183.87	91.93 81.11 69.35	59.27 58.65 43.29	31.84	23.12 19.76 16.83	14.34	8 .91 6 .83 8 .93	2.78 1.88	68.		. 48. 48.	# 6 M
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13E+13 6.#71 92E+13 1.58 19E+13 4.#4			SCODE BOUNDAR! LORENTZ VIDTH MOLECULAR VE	DOPPLER (CM-1)	. BBB32	. 88889 . 88889 . 88889 . 88889 . 88885	58888 68888 68888 68888 68888 68888 68888 68888	. 88883 . 86885 . 88885	.88887 .88885 .88883 .88888	.88875
### 2	;	I.	PLIED FAS AVERAGE AVERAGE	LORENTZ (CM-1)	.10132	.88681 .87263 .86891 .85873	.83451 .82768 .81397 .88781	.88141 .88861 .88834 .88819	. 88881 . 88881 . 88881 . 88881	. 68688
186.38 188.38 195.48	ш	ANDAKU 100K 1888 KM 1888 KM 188 DEG 188 KM	E USER SUI SUMED: 108 CM-1 88 CM-1	٠ŝ	288.20	278.45 258.78 249.28 239.28	229.78 219.48 216.78 216.78 226.58	226.28 237.27 248.68 268.86	258.87 245.45 233.85 228.97 287.81	194.33 195.18
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4 t t t t t t t t t t t t t t t t t t t	CASE 2A	SCIANT PAINT	HALFWID THE FOL		**	NWARR	F 60 60 80 11	45 45 45	13 B S 1 C S	22

TABLE B-2 (Cont.)

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BENDING	DEG		3.000.	6662	ନ୍ଧାର ହେବି । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ପ୍ରତ୍ୟ ଓ ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ପ୍ରତ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ୟୁଷ୍ଟ ଓ ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଟ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ୟୁଷ୍ଟ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ୟ । ସ୍ୟ । ସ୍ଥ । ସ୍ୟ । ସ୍ୟ । ସ୍ୟ । ସ୍ୟ । ସ୍ୟ । ସ୍ଥ । ସ୍ଥ । ସ୍ଥ । ସ୍ୟ	8 6 6	98.	. 999 999 999	999	888
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CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

2.244E+23 4.161E+23 3.753E+23 1.734E+23 1.644E+23 3.833E+23 1.073E+23 9.166E+22 7.834E+22 CH4 4.129E+18 1.918E+18 1.825E+18 3.384E+18 3.053E+18 1.411E+18 1.337E+18 2.467E+18 1.749E+18 1.545E+18 8.363E+17 5.220E+17 1.172E+18 9.931E+17 1.232E+17 1.676E+17 1.879E+17 1.823E+17 1.886E+17 2.862E+16 5.973E+16 4.350E+16 1.516E+17 2.738E+17 2.38BE+17 1.657E+17 7.383E+16 6.827E+16 1.187E+17 9.6Ø9E+16 4.82ØE+16 03 N20 CO 6.779E+16 7.772E+17 3.583E+17 3.398E+16 3.618E+17 1.622E+17 3.435E+17 6.378E+17 5.747E+17 3.295E-17 2.916E+17 1.575E+17 2.655E+17 2.518E+:7 4.643E+17 6.867E+16 9.799E+16 1.813E+17 2.198E+17 2.878E+17 1.845E+17 3.389E+16 6.523E+16 6.819E+16 5.895E+16 3.122E+16 3.216E+16 CO2 8.#14E+2# 6 3.723E+2# 3 2.738E+2Ø 2 2.596E+2Ø 2 4.788E+2Ø 5 1.857E+28 3 9.848E+19 3 7.728E+19 4 2.767E+19 3.839E+19 .542E+28 .578E+28 3.485E+28 3.819E+28 1.641E+28 1.827E+28 2.318E+28 1.982E+28 1.694E+28 1.447E+28 1.237E+28 w w m H28 1.673E+22 5.418E+21 1.611E+21 1.229E+21 1.668E+21 9.586E+28 3.863E+28 2.315E+28 2.581E+2Ø 9.979E+19 2.879E+19 1.289E+19 1.891E+19 8.815E+18 3.237E+17 5.327E+21 7.711E+21 4.751E+21 1.831E+24 9.142E+23 4.968E+23 1.873E+24 1.998E+24 1.795E+24 .298E+24 .96ØE+23 .626E+23 3.111E+23 7.828E+23 6.881E+23 1.000 1.500 2.888 3.680 4.988 11.000 12.000 13.000 15. 16. 17. 1.588 2.888 3.888 10.688 11.888 12.888 4 . 5.88 4 . 5.88 5 . 888 6.888 7.888 7.588 8.888 9.888 18.888 14.000 16.006 17.000 18.000 13.000

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U. S. STANDARD, 1976	Σ							. ଅପର DEG	
6	#1	•	Ħ						
MODEL	Ŧ	Н2	ANGLE	RANGE	BETA	IHd	NINI	BEND: NC	<u>ک</u> ان

RELATIVE TO A VERTICAL PATH . GROUND TO SPACE

LAYER AND ABOVE IS LESS THAN B. 1 PERCENT ET OF LAYERS FOR INPUT TO FASCODE
AMOUNT MAY BE SET TO ZERO IF THE CUMULATIVE AMOUNT FOR THAT TOTAL AMOUNT. THIS IS DONE ONLY FOR THE FOLLOWING CASES IEMIT = 8 (TRANSMITTANCE)
[EMIT = 1 (RADIANCE) AND IPATH = 3 (PATH LOOKING UP)

OZ IS NOT INCLUDED IF THE AMOUNTS FOR ALL THE MOLECULES BUT OZ ARE ZEROED. THE REMAINING LAYERS ARE ELIMINATED

i	20	7.43E+23	6.486+23	5.49E+23	4.68E+23	3.96E+23	3.33E+23	2.956+23	5.36E+23	2.69E+23	2.436+22
	£0 CH4	283.43 3.55E+24 2.31E+22 1.17E+21 1.82E+17 1.14E+18 5.28E+17 6.85E+18 7.43E+23	273.69 3.86E+24 1.38E+22 1.81E+21 9.91E+16 9.81E+17 4.25E+17 5.21E+18 6.48E+23	263.94 2.62E+24 6.36E+21 8.66E+2# 8.91E+16 8.4#E+17 3.46E+17 4.46E+18 5.49E+23	254.20 2.24E+24 2.90C+21 7.38E+20 8.60E+16 7.16E+17 2.91E+17 3.80E+18 4.68E+23	244.45 1.89E+24 1.26E+21 6.26E+28 9.82E+16 6.87E+17 2.48E+17 3.22E+18 3.96E+23	234.71 1.59E+24 4.90E+20 5.26E+20 1.89E+17 5.10E+17 1.87E+17 2.78E+18 3.33E+23	224.73 1.41E+24 1.29E+28 4.66E+28 1.76E+17 4.49E+17 1.44E+17 2.38E+18 2.95E+23	216.88 2.565+24 4.72E+19 8.47E+28 9.25E+17 7.87E+17 1.81E+17 4.24E+18 5.36E+23	216.7@ 1.29E+24 5.20C+18 4.25E+20 1.5RE+18 3.56E+17 3.34E+16 2.00E+18 2.69E+23	216.70 1.16E+23 4.52E+17 3.84E+19 2.79E+17 2.81E+16 1.58E+15 1.68E+17 2.43E+22
	6	5.28E+17	4.256+17	3.46E+17	2.91E+17	2.48E+17	1.876+17	1.44E+17	1.816+17	3.34E+16	1.586+15
INTEGRATED AMOUNTS (MOLS CM-2)	N20	1.14E+18	9.81E+17	8.48E+17	7.16E+17	6.87E+17	5.1ØE+17	4.49E+17	7.875+17	3.56E+17	2.81E+16
MOUNTS (M	03	1.825+17	9.91E+16	8.91E+16	8.6@E+16	9.02E+16	1.895+17	1.76€+17	9.251+17	1.586+18	2.79€+17
EGRATED A		1.17E+21	1.Ø1E+21	8.665+28	7.38E+20	6.26E+28	5.26E+2Ø	4.66E+28	8.47E+28	4.25E+28	3.84E+19
LNI	ATR HEE COS	2.316+22	1.3ØE+22	6.36E+21	2.900+21	1.26E+21	4.98E+28	1.29E+2Ø	4.72E+19	5.205+18	4.52E+17
		3.55E+24	3.86E+24	2.62E+24	2.24E+24	1.89E+24	1.59E+24	1.41E+24	2.565+24	1.296+24	1.16E+23
TBAR	8	283.43	273.69	263.94	254.20	244.45	234.71	224.73	216.88	216.78	216.78
IPATH PBAR	(MB)	929.14827	773.19998	639.19247	524.71482	427.48751	345.37569	274.71517	181.34791	90.91292	58.81539
IPATH		m	ო	m	m	m	m	m	က	m	'n
LAYER BOUNDARIES FROM	CHIH)	1.588	3.880	4.588	6.888	7.500	609.6	10.600	15.800	19.468	28.088
LAYER BO	(KW)	. 888	1.500	3.888	4.598	6.888	7.588	9.000	17.688	15.880	19.40E
			1/1	۳	•	တ	w	15	gn	€r.	16

	SECANT	1.888586	1.625655	1.688888	1 . 8688 <b>68</b>	1.388388	1 . 8 8 8 8 8 8	1.996866	1.888668	1.088888	1.888888
	PATH	٣	ю	т	m	ю	ю	m	т	٣	ю
	TYPE ITYPE IPATH	66	B	8	69	8	В	2	73		7
	TYPE 1	688.	1.189	1.423	1.139	1.374	1.112	1.369	1.358	1.798	1.397
	16.84.54 F DV	.824958	.824888	.016000	.816888	.010667	.010667	1111788.	. 884741	.002370	.881588
2	86/87/15 16 DV H2OSLF	1.8268	1.0170	1.8897	1.0052	1.9827	1.0012	1.0884	1.0001	1.8883	1 . 8888
• <u>•</u> <u>&gt;</u>	Ų	.824846	.620185	B1687B	.014049	.811644	883600%	.887788	.885236	.882637	.801697
OPTFAC MISSIV	FASCOD2 ZETA CAI	.991	. 989	. 987	.985	. 982	. 579	.975	.963	938	. 894
DPTFAC BOUNDARY EMISSIVITY	IS CM-1 ALPHV	.696183	.888748	. 867488	.056198	.046576	.038353	.031156	.828946	.0:0549	. 886787
	- RURAL AEROSOL * 986 - 918 CM-1 T(K) ALPHL ALPHO ALPHV	686383	.8888.	.000878	. 888861	. 888845	.000828	.000018	.888795	. BBB795	.6688795
988.8888. 4.88888. 36.88888. 36.8888. 8088E+38	AEROSOL . ALPHL	.896174	886738	.867469	.856185	.846561	.838335	.831135	.828915	.0:8489	.885694
VZICM-1) = VZICM-1) = DVSET = ALFALØ = AVMASS = AVMASS = SECANT =		283.43	273.69	263.94	254.28	244.45	234.71	224.73	216.88	216.78	216.78
SSAN SSAN DV3 TBI SS	SCATTERING P(MB)	929.1483	773.2888	639.1925	524.7348	427.4875	345.3757	274.7152	181.3479	98.9129	58.0154
	MULTIPLE S	1.58 KM	3.88 KM	4.58 KM	6.80 KM	7.50 YM	9.00 KM	18.69 KM	15.88 FM	19.48 FM	28.88 FM
	AER TEST CASE - MULTIPLE SCATTERING AYER P(MB)	.88 TO	1.58 TO	3.88 TO	4.50 TO	6.88 TO	7.58 TO	9.88 TO	18.68 TO	15.88 TO	19.48 10
	AER TE!	1	8	ო	•	rc	v	•	an	சு	1.0

4.737E+22 6.718E+21 3.538E+18 6.412E+18 2.369E+18 3.423E+19 4.255E+24 1.683E+25

AER	TEST	CASE	- MULTIPL	E SCATTERING	- RURAL	AERCSOL	TEST CASE - MULTIPLE SCATTERING - RURAL AEROSOL * 988 - 918 CM-1		FASCOD2 86/87/15 16.84.54	6.84.54			
				PCMB	10%	T(K) IPATH	MOLECULAR AMOUNTS (MOL/CM**2) BY LAYER HZR COZ O3	TS (MOL/CM**2)		00	CH4 02	OTHER	~
	.0.	OT 60.	1.50 KM	929.14627	283.43	m	2.314E+22 1.174E+21 1.817E+17 1.138E+18 5.295E+17 6.847E+18 7.434E+23 2.786E+24	+21 1.817E+17	1.1386+18 5.	2#5E+17 (	5.847E+18 7.434	E+23 2.78	6E+24
61	1.56	1.50 TO	3.88 KM	773.19998	273.69	ო	1.304E+22 1.011E+21 9.912E+16 9.806E+17 4.254E+17 5.209E+18 6.464E+23 2.488E+24	+21 9.912E+16	9.8066+17 4.	254E+17 !	5.289E+18 6.484	E+23 2.48	185+24
ю	3.88	3.88 TO	4.58 KM	639.19247	263.94	ო	6.362E+21 8.665E+28 8.985E+16 8.482E+17 3.459E+17 4.464E+18 5.488E+23 2.868E+24	+28 8.985E+16	8.482E+17 3.	459E+17	1.464E+18 5.488	E+23 2.06	85+24
~	4.55	4.58 10	6.98 KM	524.71482	254.28	ea	2.897E+21 7.385E+2# 8.595E+16 7.161E+17 2.9#9E+;7 3.8#4E+18 4.677E+23 1.765E+24	+28 8.595E+16	7.1616+17 2.	989E+17	3.8#4E+18 4.677	£+23 1.76	55+24
ம		6.08 TO	7.58 XM	427.48751	244.45	m	1.265E+21 6.256E+2# 9.#16E+15 6.#66E+17 2.395E+17 3.221E+18 3.962E+23 1.496E+24	+2# 9.#16E+15	6.#66E+17 2.	395E+17	3.221E+18 3.962	E+23 1.49	165+24
ص	7.54	7.5g TO	9.88 KM	345.37569	234.71	က	4.895E+2# 5.263E+2# 1.#87E+17 5.1#1E+17 1.87#E+17 2.7#5E+18 3.333E+23 1.259E+24	.+28 1.887E+17	5.1Ø1E+17 1.	87.0E+17	2.7#5E+18 3.333	IE+23 1.25	9E+24
7	9.8	9.88 TO	10.50 KM	274.71517	224.73	т	1.285E+28 4.660E+28 1.764E+17 4.491E+17 1.443E+17 2.382E+18 2.951E+23 1.115E+24	1+2# 1_764E+17	4.491E+17 1.	443E+17	2.382E+18 2.951	E+23 1.11	5E+24
60	10.5	40	18.58 TO 15.88 KM	181.34791	215.88	m	4.721E+19 8.468E+20 9.253E+17 7.079E+17 1.810E+17 4.235E+18 5.363E+23 2.827E+24	+2Ø 9.253E+17	7.8788+17 1.	810E+17	4.235E+18 5.363	3E+23 2.8	27E+24
o	15.8	15.88 TO	19.48 KM	98.91292	216.78	٣	5.198E+18 4.248E+20 1.582E+16 3.564E+17 3.335E+16 1.996E+18 2.694E+23 1.817E+24	:+20 1.582E+16	3.564E+17 3.	335E+16	1.996E+18 2.69A	FF+23 1.8	17E+24
	19.48 TO	70 10	26.88 KM	58.81539	216.78	m	4.519E+17 3.839E+19 2.791E+17 2.887E+16 1.588E+15 1.576E+17 2.431E+22 9.191E+22	:+19 2.791E+17	2.8Ø7E+16 1.	.58ØE+15	1.576E+17 2.431	E+22 9.19	31E+22
							ACCUMLATED MOLECULAR AMOUNTS FOR TOTAL PATH	CULAR AMOUNTS	FOR TOTAL PA	VTH			;

86/83/25 12.55.52 8CDMRG2 LINE FILE FOR FASCOD2 PKG FOR BB# - 1199 CM-1 LINE FILE INFORMATION

	INF - 1199.985
2.8872E-24 1.4911E-28 4.9883BE-28 4.9884BE-22 9.7259E-24 9.7259E-24	ANT L TARRESTO
2.0088 19.725 17.72 2.08 2.26	000
111111 C002 CHC0310 CHC0310	

22794

TOTAL NUMBER OF LINES -

251.73

533.71191

20.88 KM

O1 90.

				8915+68 8715+88 7925+88 1185+88
		TAN TO THE STATE OF THE STATE O	10 10 10 10 10 10 10 10 10 10 10 10 10 1	.87538886 .877469715 .87757926 .877421186
THE PARTY OF THE P	25.00 25.00	8 4 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3		.68365738E-86 .67752379E-86 .6756485E-86 .67795977E-86
APTER RESIDENCE CONTRACTOR CONTRA	989 989 989 989 989 989 989 989 989 989	SAFTER REJECT 86/87/15 16	A CALLED AND A CAL	969.912686 969.936886 969.968686 969.96868
3. 30. E	8 6 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	1. NO. LINE	LOCATION	489 68
R - SOUNDF3 C CA		S - 4 - 3 - 3 - 3 - 3 - 3 - 3 - 3 - 3 - 3	THE STATE OF THE S	
25.8668 FTER SHRIM PANEL		64, MO. LINE Sol * 966 -	VITH XTYPE-	
UND FOR LAIF4 = E59, NO. LINES A CONVOLUTION .938	VOLUTION -885 WIDTH CHANGES	ZETA = - RUR -22.77E	ONTO FILE 23  J ONTO FILE TRANSMITTANC	.886#2463E+## .886#1474E+## .886#8271E+## .88598842E+##
8 80 READ 826		AVERAGE SCATTERING	AVER 18 AVER 11	.61784845E-#6 .61794864E-#6 .61845285E-#6 .61818611E-#6
4 = 1.536 BEFORE SHRIN INE 612	MAVENUMBER 988.824888 988.824888 988.872888 988.972888 71ME	17486 1SE - MULT START OF	LAYER I FINAL L. 25 MERGED WITH FILE LAYER I FINAL L. 18 MERGED WITH FILE 1 WAVENUMBER RADIA	966.824666 966.824666 966.84666 966.872688
DV FOR LBLFA NR. LINES 72. MIRAC	1925 1925 1926 1927 1929 1929	AVERAGE VIII AER TEST CA	INITIAL LA INITIAL LA INITIAL LA LA ELLE IN LA LA LA LA LA LA LA LA LA LA LA LA LA	

\*\*\*\*\*\*\*\* CONTINUA: H20(T),C02,N2 (#1 JULY 82)

ARE FEST CARE - MULTIALE SCATTERING - AUGAL AREAGOD, \$ \$18 - 912 PM-1   AVECODY TREATER FOR CALL   AVECODY TREATER   AVE		1 988 88888 2 966 824888 3 986 824888 4 988 872688 5 988 89688 [EDUINED FOR EN	20177942E-84 8 38177944E-84 8 38177944E-84 8 38177899E-84 8 38177842E-84	#4 12929846 #4 129293565 #4 129293565 #4 129293125			444 44 440 V8	966.917888 969.957888 969.966688 969.96488 918.88888	.296.48.78E-194 .296.4856E-184 .296.4922E-184 .296.48417E-184 .296.45918E-184	138986466-41 138986466-41 13183776-41 138934886-41	e fag.
1	AE TÉ		IPLE SCATTERING	- RURAL AEROS	105		100 100 100 100 100 100 100 100 100 100	91/4#/98	25年100年 25年20年 25年20年 20年21年 20年 20年21年 20年		
LBLE4	LAVER	*	#2		82) USE.T), HŽO SĘ	F HAS SEER	REDUCED	The State of the S	268 CM-1 REGIO		And the second s
######################################	DV FOR I			FOR LBIF4	25.8888	40 31	NO. LINES	AFTER REJEC	1	· · · · · · · · · · · · · · · · · · ·	
HINACIE   18		TIME 72.932		WOLUTION .	PAREL BBB.				न्त्रम् १८८६ च्याच्याच्याच्याच्याच्याच्याच्याच्याच्या	=	BF. S
17. 988.84888 17256183E-81 18. 988.84888 17256183E-81 18. 988.84888 17256183E-81 18. 988.84888 17256183E-81 18. 988.872888 1722614E-81 18. 988.872888 1722614E-81 18. 988.872888 1723637E-81 18. 988.872888 1723637E-81 18. 988.872888 1758586E-86 1873 18742 18742 187567715 16.  18. 18. 18. 18. 18. 18. 18. 18. 18. 18.	F. TUNTOO	ON FILE 18	>0 PE	. 第24節節節	B00M		6.144		When and	The control of the co	ABLE
1446   989-968888   1722614E=81   1441   989-968888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-8888   1888-988-888   1888-988-888   1888-988-8888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888   1888-988-988-888-988-988-988-988-988-988	1825		.17284378E-8:				1438	969.912666	.28542386E-#1	The state of the s	
TIME 73.852  .813 .813 .814 .887 .887 .887 .887 .887 .887 .887 .88	1828				A Part of the second of the se		1448	989.968888 989.984888 918.88888	.282239596-81 .285818436-81 .289281126-81	in in in in in in in in in in in in in i	And the second
CE VIDTH *		C)		VOLUTION .874	PANEL BR7		: 				Marie y Marie Carlo Marie Carlo Marie Carlo Marie Carlo
THE AT THE START OF RADMRG IS		VIDIH .		WIDTH CHANGES ZETA = .97954	47, NO. LINES	N Y W	S. LINES	AFTER RESECTION	321.	TV CHANGES .	
A   THE START OF RADMRG   S   73.866     A   LAVER     FINAL LAVER   2     A   NERGED WITH FILE   11 ONTO FILE   12     A   NAVENUMBER RADIANCE   TRANSMITTANCE   1989-912888     948-82888   757568686-86   862897686-88     948-875888   75768376-86   86286136-88     948-875888   757848836-86   86286136-88     948-875888   757848836-86   862843586-88     948-875888   7588788686-86   862814956-88     948-875888   758288686-86   862814956-88     948-875888   758288686-86   862814556-88     948-875888   758288686-86   86281456-81     948-875888   75828888   758288686-86     948-875888   75828888   758288686-86     948-875888   75828888   7582888     1   948-875888   7582888   7582888     1   948-875888   7582888   7582888     1   948-875888   7582888   7582888   7582888     1   948-875888   7582888   7582888   7582888   7582888   7582888   7582888   7582888   7582888   7582888   75828888   7582888   7582888   7582888   7582888   7582888   7582888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   75828888   758288888   758288888   7582888888   7582888888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   758288888   7582888888   758288888   758288888   758288888888   75828888888   758288888888   7582888888   7582888888   7582888888888   7582888888   7	AER TES	CASE -	IPLE SCATTERING	- RURAL	116 - 988 - 91	7 CH-1	Asco82	86/87/15 10	5.84.54		3 a.
18 MERCED VITH FILE 11 ONTO FILE 12  AND IANT 3 A LOCATION WAVENUMBER RADIANCE TRANSMITTANCE TRANSMITTANCE TRANSMITTANCE TRANSMITTANCE TRANSMITTANCE TRANSMITTANCE TRANSMITTANCE TO SESSION SESSION TO SESSION SESSION TO SESSION SESSION TO SESSION SESSION TO SESSION SESSION TO SESSION SESSION TO SESSION SESSION TO SESSION SESSIO	THE TIL	AT THE							, <b>-</b>		
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988.824888 75756868E-86 8628976#E+88 414 989.912888 988.824888 75756837E-86 86288375E+88 415 989.912888 988.824888 7576837E-86 86286375E+88 415 989.936884 988.872888 75784883E-86 86284358E+88 416 989.968889 988.872888 75883789E-86 86284358E+88 988.872888 75828868E-86 86281495E+88 988.872888 418 918.889889 988.896888 75828868E-86 86281495E+88 988.896888 418 989.912888 988.8988886 3881886E-84 13672841E-81 414 989.912888	LOCATIO		RAĐIAMCE	TRANSHITTANG	les C		OCAT16N	VAVENUMBER	&ADIANCE	TRANSMITTANCE	. चेंके - ` -
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WAVENUMBEN COMP FLUX UP COMP REFLECT UP LOCATION WAVEN SEG BESES 38818486E-84 13672841E-81	ന എന്				\$ \$ \$ \$ \$ \$ \$		416	989.968888 989.984888 918.888886	.83115899E-#6 .83527##4E-#6 .844453#2E-#6	.852057816+80 .851572576+80 .850591786+90	•
988.888886 .38818886E-84 .13672841E-81	LOCATI		COMP FLUX UP	COMP REFLECT	dn F		ÖCAT 10N	VAVENUMBER	COMP FLUX UP	COMP REFLECT I	; ·
	-	886	. 3##1###6E-#.		61	2 2 3 3 3 3 4 4 4 4	114	989.912888	.29462#67E-#4	137894148-81	

2 908.824888	. 368187496-84	.136724#3E-#1	:	\$ 1 F.7.	989.9368	# ". 294657##E-#4	137377628-01		
968 . F49888 968 . G72668 968 . B96868	3##1#675E-#4 3##1#576E-#4 3##1#49E-#4	.13671838E-81 .13671866E-81 .13678898E-81	· •		959.964559999999	# .29466437E-#4 # .29464165E-#4 # .29464165E-#4	.1372521E-#1 .1372521E-#1 .13698995E-#1		
TIME AT THE END OF	END OF RADMRG IS WERE REQUIRED FOR THIS	73.136 THIS MERGE				esi			
			en de la compa		STATE OF	The second secon			
AER TEST CASE - MULTIPLE	PLE SCATTERING -	RURAL MEROSOL	* 988 - 918 CM-	FASCOD	2			1. 14.	- <u>-</u>
3 CONTINUA	. H20(1),C02.N	12 (#1 30LY #2)							10 III
	02(16@BCH-	). 03(	T), H2C SELF HAS	S BEEN REDUCED	IN THE	BBB-1268 CM-1 REGION	N (#1 SEPT 1988)		
	8 SOUND FO	.BLF4 =	25.0000 1100 Cubink a	1 0 X	LINES AFTER RE	REJECT - 179			
INES BEFORE SHRINK TIME 73.258	READ			;	!			TABL	
HIRACI UTPUT ON FILE 16 LOCATION WAVENUMBER	DV - 00PT. 0EPTH	"也16年前日前年	BOUNDF3(CN	-1) - LOCA	4.8968 TION VAVENUMBER	BER BOPT. DEPTH		≅ B-2 (	24 1 12 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
966.696669 966.616686 966.832686 966.848866	.58995145E-82 516875E1-82 516875E-82 5164555E-82 51881618E-82			A 4 4 8 8 4 4 4 8 8 8 8 8 8 8 8 8 8 8 8	989.935 989.952 989.748 989.984	888 (61512844E-\$2 888 (61467615E-\$2 888 (62111438E-\$2 888 (6211438E-\$2 888 (63153316E-\$2		(Cont.)	eran germanian ya
TIME 73.364	READ CONVC	유입	PAKEL			24. 1	0.4g 1	·	
18 HTCIV	5278. AVERAGE	VIDTH CHANGES ZETA 975949.	NO. LINES .	248. NO. L	INES AFTER RE	JECT - 248, NO.	HU CHANGES . 11	,.	#. Lev man :
ST CASE - MULTIP	LE SCATTERING	- RURAL AEROSOL	* 988 - 918 CH	-1 FASCOD	92 86/87/15	16.84.54			· · · · · · · · · · · · · · · · · · ·
TIME AT THE STAR	T OF RADMRG 15	73.379						in.	
LAYER 1	FINAL LAVER 3					25 ° का 1			· · ·
18 MERGED WI AND LANT 3	WITH FILE 12 ON'	ONTO FILE 11	4.	100 (100 (100 (100 (100 (100 (100 (100					
LOCATION WAVENUMPER	PADIANCE	TRANSMITTANCE		LOCATION	WAVEN	EP PADIANCE	TRANSMIT		
988.88888	. 78793664E-86	. 558188162+88		2 12 12 12 12 12 12 12 12 12 12 12 12 12	2 989.93	M . A6817319E	.846298		
968.816866 968.632866 988.848886	78881628E-86 7 78812156E-86 7 78824286E-96	.858178996+88 .85816679E+88 .85815253E+88			3 939,95 4 989,96 5 989,98	2608 .366:4972F-86 8008 .66723157E-86 4008 .87587384E-86	. 84533696E+88		
986.864888		. 8581351#E+##		979	918.888888	888 .87677568E-8	6 ,84519462E+##		
LCCATION WAVENUMBER		COMP REFLECT U	•	LOCATION	ION VAVENUMBER	MBER COMP FLUX UP	COMP REFLECT UP		* ***

			**************************************		622	979.936BBB	. 294#9933E-84 .	. 13445645E-W1	
NF	9000、10mm 10mm 10mm 10mm 10mm 10mm 10mm 1	.29963245E-#4 . .29963187E-#4 .	13429416E-81 13429##1E-#1	 . r 		の事の、今のに をある。今のの のをの ののの。	. 294.81836-84 . 294897886-84 . 194641116-84	.13451417E-81 .13443628E-F1 .13418878E-F1	
, <del>-</del>		. 29963114E-#4 .	34284956-81				4	.   34#3#54E-#:	
un	988.864828	. 29963#2#6-84	.:342785#6-#1		424				
THE TIME	ME AT THE END OF RADMR.	F RADMRG IS REQUIRED FOR THIS	73,483 S MERGE		**		<u>.</u>		
					40	-	9 rosef	e	
AER TEST LAVER =	AER TEST CASE - MULTIPLE LAYER - 4	PLE SCATTERING -	RURAL AEROSOL			2			
****	**** CONTINUA: H2	UA: H20(T),CG2,N2 02(168#CH-1)	2 (#1 JULY 82) 1), 03(BIFFUSE.T)	). HZO SELF HAS BEEN	EN REDUCED	IN THE 888-1288	128# CP-1 REGION	(B) SEPT 1985	_
LBLF4	1.4 4 3.824EB		LBLF4 - 25						
NB. LINES BEFORE	FORE	. 647.	NO. LINES AFTER SHRINK	SHRIKK . 189.	NO. LINES	. AFTER REJECT	CT - 179		
¥.	TIME 73.599	READ CONVO.	CONVOLUTION F	PAKEL . 898		-			
HIRACI OUTPUT ON FILE	AC! 18	• AQ	.81689328	EGUNDF3(CM-1)	#36#·#		in the second		
LOCATION	VAVENUMBER	OPT. DEPTH		٠,	LOCATION	VAVENUMBER	OPT. DEPTH	<u>-</u>	
1825	988.685888 988.815888	.13332791E-#2 .13333825E-#2			1646	909.936888 909.952080	,16636445E-#2 ,16744265E-#2		•
1827 1828 1829	988.822888 988.84888 968.864888	.13358344E .13358451E		· ·	1648	969.968866 969.984666 916.66666	.172619546-#2 .188637626-#2 .1939:#716-#2		
	717E	READ CONVO	CONVOLUTION .	19年代 6年後、					
AVERAGE WIDTH		15 HALF WI	WIDTH CHANGES ZETA = .972#97, N	NC. LINES . 248.	NO. LINES	AFTER REJECT	O 20 70 71	HV CHANGES .	ŭ
AER TEST CASE	CASE - PULTIPLE	SCATTERING	- RURAL AEROSOL .	988 - 918 CH-1	FASCOCI	86/87/15	16.04.54	•	
THE TIME			73.724						
INITIAL LAYER		I FINAL LAVER &							
FILE CNTRL AND	FILE IN MERGED WITH FIL.	TH FILE II ONTO	TO FILE 12				, -1 '- <del>p</del>	z	
LOCATION	WAVERUMBER	FADIANCE	TRANSHITTANCE		LOCATION	VAVERUMBER	RACIANCE	*	
ti	948.678476 988.615486	.79474547E-#6	.85691#116+#0 .8569\$@86E+##		69.69 (11)	989.95286D 989.95286D	.876;5964E-86 .8742;5965-86		
en ⊲ y.	964.431764 966.448967 967.464898	79585951E-#6 79585951E-#6 7951-884E-#6	.856883#15+68 .856873#35+48 .856854#25+88		6 6 6 11 11 11 4 11 15	969.968888 969.984686 916.88888	. 845 k 985 k 17 k 26 k . 886 k 11 k 17 k 17 k 1 k 1 k 1 k 1 k 1 k 1	.01178947E+ <b>86</b> .84367647E+ <b>66</b> .84342465E+ <b>88</b>	
LOCATION	VAVERUMBER	COM	COMP REFLECT UP		LOCATION	VAVEHUMBER		COMP REFLECT	•
	988 . 868888	. 29946#47£-#4	. 1336635#E-#1		223	984 . 936 <b>88</b> 8	-29389157E-84	TO STATE OF THE ST	

### SECS WERE REQUIRED FOR THIS MERGE  #### SECS WERE REQUIRED FOR THIS MERGE  ##################################	•
ST CASE	- 918 CM-1 FASCO02 86/87/15 16.84.54
ST CASE - WULTIPLE SCATTERING - RURAL AEROSOL - 998 - 918 CM-11 FASCO  SELFA68267 BOUND FOR LBLF4 - 25.8888	- 918 CM-1 FASCODZ 86/87/15 16.84.54
SEF4 *   CONTINUA: HZO(T), COZ, NZ (#1 JULY #2)	
SEF4   SEC67   BOUND FOR LBLF4   SOSSER	SELF HAS
TIME	
- THE READ CONVOLUTION PAREL  - 1959	INK - 234, NO
CON TILE 18 BOUNDESCENT BOUNDESCENT: CONTROLL COCA WAVENUMBER OPT. DEPTH  100 988.8 8888.8 13286.666.8 13286.8 193  988.8 1333 13286.666.8 133  988.8 1333 13286.666.8 133  988.8 1333 13286.8 133  988.8 1333 13286.8 133  988.8 1333 13286.8 133  1988.8 13388 13286.8 133  1988.8 13388 13388 13286.8 133  1988.8 13388 13388 13286.8 1388 1388 1388 1388	NE!
100   WAVENUMBER   DPT   DEPTH	_
155 9988 818557 3295856565-83 159 988 821333 329429595-83 159 988 821333 329429595-83 159 988 821333 329429595-83 159 988 821333 329429595-83 159 988 821333 32942955-83 159 988 821333 32942955-83 159 988 821333 329426565-848 385 - 918 CM-1 FASC 14. AVER ACT THE START OF RADMRC 15 74.876 14. AVER 1 FINAL LAVES 5 12.0NTO FILE 11 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 15. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 16. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 17. WAVEN, MSCP PADIANCE TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAT THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF RADMRC 15 TRANSMITTANCE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF THE 10.058 18. WAS THE START OF	LOCATION WAVENUMBER OFT. DEPTH
TIME READ CONVOLUTION PANEL  -4.862  -4.863  -	1953 989.952688 .44623824E-83 1959 989.962667 .46848285E-83 1958 989.973333 .4868193E-83 1951 989.994667 .59472198E-83
AG WINTH WERE SCATTERING - RURAL AEROSOL * 988 - 918 CM-1 FASC TEST CASE - MULTIPLE SCATTERING - RURAL AEROSOL * 988 - 918 CM-1 FASC TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FASC TAL LAVER I FINAL LAVES S TAL LAVER I FASC TAL LAVER I FINAL LAVES S TAL LAVER I FASC TAL LAVER I FINAL LAVES S TAL LAVER I FINAL LAVES S TAL LAVER I FASC TAL LAVER I FINAL LAVER S TAL LAVER I FASC TAL LAVER I FA	NEL Ø12
TEST CASE - MULTIPLE SCATTERING - RURAL AEROSOL % 988 - 918 CM-1 F.  THE AT THE START OF RADMRC 15 74.876  TALLAVER 1 FINAL LAVES 5  TO MERGED WITH FILE 12 ONTO FILE 11  AND TAKEN WEER PARTICLE 12 ONTO FILE 11  TRANSMITTANCE 1847  TO 922. PREEGE 7.796.36.11E-F6 .856.358.86.88  TO 923.81.8667 .796.36.71E-F6 .856.358.86.88	INES - 192. NO
14. AVER 1 FINAL LAVES 5 74.876  14. AVER 1 FINAL LAVES 5  15. MEPGED WITH FILE 12 ONTO FILE 11  26. MEPGED WITH FILE 12 ONTO FILE 11  27. WAVENCEPPEDE 79638711E-F6 8553886-88  298.87133 796486976-85 8553886-88  298.87133 796486976-85 8553886-88  2988.87133 796486976-85 85538496-88  3988.87133 796486976-85 855384286-88  4 7089.872898 79684446-85 85544228-88	- 91.5 CM-1
18. ANCR : FINAL LAVES 5 12 MERGED WITH FILE 12 ONTO FILE 11 20. JAN 3 8 TRANSMITTANCE 1920. PRESENT 1796.35.11E-F6 886535885+88 2 958. R19667 796.35.11E-F6 886535885+88 2 958. R19667 796.36.11E-F6 88653585+88 2 958. R19667 796.36.11E-F6 88653585+88 3 958. R19667 796.36.11E-F6 88653585+88 4 708. B32888 7965454E-B6 886531422E+88	
ANT   ANT   ANT   FILE	
TRANSMITTANCE  1922. PPPROG 79635/11E-P6 .85653588E+88  2923. P18667 .79648697E-P6 .85653584E+88  2924. P18667 .79648697E-P6 .8565388E+88  4 .098. P1833 .7964864E-P6 .85651462E-88  4 .098. P1833 .7964844E-P6 .85651462E-88	
920, PPPRDP 779535111E-06 85653588E-28 503, R18667 7964869nE-05 9555382E-88 988,821333 79647188E-86 95552382E-88 788,821888 79654644E-86 95551422E-88	LOCATION MAVENUMBER RADIANCE TRANSMITTANCE
903.010667 .796406978-85 .855590498-80 900.02133 .796471888-86 .085623078-80 1000.022002 .79554648-85 .085622002	34 989.952888 .876.8631E-86
	935 989.96267 87645349E+#6 84444899E+## 936 989.973333 88#51167E+#6 8439278E+## 937 989.984### 8875#159E+# 843#1921E+##
./yeecyseride .doougelocate	938 989.991667 .88775928E-86 .81295869E+88
COCATION MAVENUMBER COMP FLUX UP COMP REFLECT UP	LOCATION WAVENUMBER COMP FLUX UP COMP REFLECT UP

「他・日本の名はいだだ」、「本年・日の大のなだのかって、「「をおおおから、これない」	934	949.952888	. 29382149E-#4	.1335#943E-#1
1. 48-35:000000000000000000000000000000000000	\$66 66	989.962667	.29381295E-#4	10346148F-81
・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・ ・	0 r-	98486	193111911191	161-040-140-1111111111111111111111111111
5 900.04266 . 19939683E-04 .13348985E-01	938	189.934667	.29378781E-84	.:329#828E-@:
THE TIME AT THE END OF RADWRG IS 74,222. IA6 SECS WERE REQUIRED FOR THIS MERGE				
AER TEST CASE - MULTIPLE SCATTERING - RURAL AEROSOL " 948 - 918 C	CM-1 FASCODZ	86/87/15 16.	.84.54	
*********** CONTINUA: HZO(T), COZ.NZ (#1 JULY 82)  O2(1689CM-1), O3(DIFFUSE.T), HZO SELF	HAS BEEN REDUCED	IN THE 848-1255	BE CH-1 REGION	(#1 SEPT 1985)
181F4 S8267 BOUND FOR LBLF4 = 25. BBEB DV FOR LBLF4 S8267 BOUND FOR LBLF4 = 25. BBEB 638. NO. LINES AFTER SHRIMK	234. NO. LINES	. AFTER REJECT	. = 219	
READ CONVOLUTION				
10 0V = 1966667 80UNDF	(3(CM-1) + 2.73#7		-	
HEAD FAC AUGUSTA	LOCATION	WAVENUMBER	OFT. DEPTH	
	1958	909.9528## 909.962667	118895818E-83	
988.821333 .698834545 988.832882 .697945445 988.842667 .699249999	1968 1961 1961	989.973333 989.984888 989.994667	.1282#5#15-#3 .14943587E-#3 .18566758E-#3	
TIME 74.457				
AVERAGE UIDTH = .826835. AVERAGE ZETA * .958691. MO. LINES =	192, NO. LINES	AFTER RESECT	- 192. NO. H	HV CHANGES - 15
T CACE - MILTIPLE SCATTERING - RURAL AEROSOL * 986 - 918	CM-1 FASCOD2	86/87/15 16	.64.54	
AT THE START OF R				
INITIAL LAYER I FINAL LAYER 6				
FILE 16 MERGEN WITH FILE 11 ONTO FILE 12 CHTRL AND IANT 3 E				
- CLATTON CAVINIER PADIANCE TRANSMITTANCE	LOCATION	WAVEHUMBER	RADIANCE	TPANSHITTANCE
988.828882. 796713986-866 988.8189857. 796759836-86	935	989.952 <i>88</i> 8 989.962667	.8766366#E-#6 .8769245#E-#6	,我本本公子公司的医士德特 ,我本本公司的包含是干糖的
988,821333 .796824142-86 . 988,832837 .79689685-86 . 988,84266 .796981972-86 .	9.6.6.6.6.8.6.8.6.8.6.8.8.8.8.8.8.8.8.8.	909,973333 909,984669 909,994667	. 8888657295 - 86 . 888867795 - 96 . 888428855 - 86	. 843.48123E+管理 . 5418509111・電車 . 84115988E+管理
	LOCATION	VAVENUMBER	COMP FLUX UP	COMP REFLECT UP
37858E-84 .13346366E-81	934	989.952888	.2937956FE-84	.13345531E-E:

ED IN THE BEB-1288 CM-1 PEGION ES AFTER REJECT - 187  NES AFTER REJECT - 187  NES AFTER REJECT - 187  S09:991111 .48594852E-84  989:991111 .88841965E-86  86/87/15 16.84.54  N VAVENUMBER PADIANCE TO S09:96978 .87941965E-86  989:96978 .87941266E-86  989:96978 .87941265E-86  989:96978 .88944614E-86 .89	2 948.818667 .2 3 988.421333 .7 4 988.832888 .22 5 988.842667 .72	29937841E-64 29937899E-64 29937763E-64 2993778E-64	.133462#8E-#1 .13345968E-#1 .13345661E-#1		49 46 M M M M M M M M M M M M M M M M M M	989.962667 989.973333 989.973333	481-3000000000000000000000000000000000000	13348484E-#1 13386888E-#1 13386888E-#1	
	988.8426 E AT THE EN:	377825-84 485 15 15 FOR THE	74,683		7 88 85 86 86 86 86 86 86 86 86 86 86 86 86 86	989.584 <b>88</b> 189.994667		.13286895E-#1	
The compliance continues are continued as the continues are continues as the continues are continues as the continues are continues as the continues are continues are continues are continues as the continues ar		2 - 0 0 1			e e e	· - · - <u>-</u>	. 4		
PAGE   PAGE	2011 JOH - 2007								
Fig. 1	***** CONTINUA:	ſJ	(81 JULY 82 , 03(01FFUSE	. H2O SELF HAS BE	REDUCED	¥ .	CH-1	SEPT 1985	
SECRE SHILLS	54 • 27	816. • F	800ND4 - 25	•					
PAME	FFORE SHRINK	8044D FO	LBLF4 = 25.8 O. L!NES AFTER	1NK - 199		AFTER REJE	. 18		
FILE 10		EAD C	UTION .841	PANEL . 241					
DOCATION   WAVENUMBER   OPT. DEPTH   DOCATION   WAVENUMBER   OPT. DEPTH   OPT. DE			111118	BOUNDF3(CM-1)	1.82				
988-80888 11997688E-84 988-80133 1112487F-84 988-80133 111248777E-84 988-80133 111248777E-84 988-80133 111248777E-84 988-80133 111248777E-84 988-80133 11248777E-84 988-80133 112487E-84 988-80133 179587E-86 988-80133 179597E-86 988-80133 179587E-86 988-80133 179587E-86 9	VAVENUMBER				LOCATION	VAVENUMBER			
988-828144 .113877776-84  TIME					427 428 429 436		<b>a a a a</b>		
TIME READ CONVOLUTION PANEL  4.841  .312 .312 .312 .312 .312 .313 .314 .315 .315 .315 .315 .316 .316 .317 .316 .317 .318 .318 .318 .318 .318 .318 .318 .318	.828444	1777E			3	9.59822	5318		
The case   Multiple Scattering   Layer   Lay	TIME 4.841	EAD 312		PANEL . 813					
TOSE - MULTIPLE SCATTERING - RURAL AEROSOL * 968 - 918 CM-1   FASCOD2   86/87/15   16.84.54			H CHANGES				8	6 1 2 4	
E AT THE START OF RADMRG IS 74.856  E AT THE START OF RADMRG IS 74.856  LAYER I FINAL LAVER 7  LAWER I FINAL LAVER 7  I M MECED WITH FILE 12 ONTO FILE 11  D I ANT 3 PROSCOZZE 6 85639975E-09  988 002332 756889 186186-09  988 002332 756889 186186-09  988 002332 756889 186186-09  988 002333 7569151E-06 85639635E-06  988 002333 7569151E-06 85639635E-06  988 002333 7569151E-06 85639636603E-06  988 002333 7569151E-06 856396036E-00  1486 989.99111 88841965E-06  988 002333 7569152E-06 856396036E-00  1487 989.99111 88841965E-06	· HEGEN		. 949873.	LINES - 158	NO. 1 1 NE	TER REJE	154 NO.	CIPARE	
LAYER 1 FINAL LAYER 7  10 MERGED WITH FILE 12 ONTO FILE 11  11 MERGED WITH FILE 12 ONTO FILE 11  12 MERGED WITH FILE 12 ONTO FILE 11  13 MAVENUMPER PADIANCE TRANSMITTANCE LOCATION WAVENUMPER PADIANCE 1488 988.95555E.86  988.007.11 79583299F.86 85339518E.88 1485 989.96878 888448386E.86  988.007.11 79583298F.86 85338518E.88 1485 989.991111 88841965E.86  988.007.13 79687131 788841965E.88 1487 989.991111 88841965E.86	CASE - MULTIPLE	ATTERING	AEROSOL	988 - 918 CM	FASCeb2	6/87/15 1	•		
LAYER     FINAL LAVER   7	E AT THE START OF	ADMRG 1	4.85						
WAVENUMBER         TRANSMITTANCE         LOCATION         WAVENUMBER         PADIANCE           9R8.05372         1983.052E-86         1883	LAYER 1 FINAL 18 MERGED WITH FI	AVER 12	FILE						
1483   989-969778   875125E-86   87539775E-88   1484   989-969778   87341255E-86   887111   79660299E-86   8553958E-88   885395E-86   885395B-88   88848386E-86   8871222   79687113E-86   885395B-88   88848386E-86   8871333   7969754E-86   885396B-88   88848386E-86   8871333   7969754E-86   88538836E-88   88844614E-86   88538836E-88   88844614E-86   88538836E-88   88844614E-86   88844614E-86   88538836E-88   88844614E-86   88538844614E-86   8853844614E-86   88538844614E-86   885388448484614E-86   88538844614E-86   88538844614E-86   8853884484848484848484848484848484848484	WAVENTABER	N C E	TRANSMITTANCE		LOCATION	WAVENUMBER			
.79691541E-#6 .865386#3E-#6 .84273983C+# .79696397E-#6 .65638#36E+### .84272998222 .88844614E-#6 .84272965E+#	.000000 .007111 .014222	7632E-86 3299E-86 7113E-86	.85639725E+ <i>08</i> .85639518E+ <i>00</i> .856391 <i>8</i> 3E+ <i>208</i>		1483 1484 1485	969778 976889 984888	.87941255E-#6 .08365555E-#6 .8884#3#6E-#6	.843955462+88 -84348;342+88 .84274588E+88	
		541E-#6	.85638 <b>6#3€÷##</b> .85638£36 <b>€÷##</b>		1486	989.991111	.88841965E-86 .88844614E-86		

LOCATION WAVENUMBEP COMP FLUX UP COMP REFLECT UP	LOCATION	WAVENUMBER	COMP FLUX UP	COMP REFLECT UP
1 900.0000000 .29936992E-04 .13344216E-01 2 900.007111 .29936907E-04 .13344796E-01 3 900.014277 .749364747-04 .13344798E-01	200 mm 1 mm 1 mm 1 mm 1 mm 1 mm 1 mm 1 m	969,969778 969,975889 969,975889	.29375357E-84 .29371536E-#4 .29366255E-#4	.13326179E-#1 .133#5948E-#1 .132##675E-#1
4 908.8213\\\\2993695E-#4 .13343844E-#1 5 988.82844 .29936925E-04 .13343649E-#1	1466	200806 646	.29266#98E-@4 .29265847E-84	13288281E-81
THE TIME AT THE END OF RADMRG IS 75.215				
AER TEST CASE - MULTIPLE SCATTERING - RUPAL AEROSOL " 968 - 918 CM-1	FASCOD2	86/87/15 16	.94.54	
LAYER - 8				
********* CONTINUA: H2O(T),CO2,M2 (B1 JULY 82)				
02(1688CM-1), 03(D1FFUSE,T), H20 SELF HAS BI	BEEN REDUCED	IN THE 889-1268	PER CH-1 REGION	(#1 SEPT 1985)
****** 1PTS4 = 41 DVR4 = .68681 BOUND4 = 25.88888 ****				
IBEF4 - GEES! BOUND FOR LBLF4 - 25.68888		_		
MS. LINES BEFORE SHRINK . 637, NO. LINES BYTER SHRINK . 253	I. NO. LINES	AFTER REJECT	T = 238	
TIME READ CONVOLLTION PANEL 75.186 .825 .8881				
(I-MD)SICH-1488 PARK TO SI BILLY NO LOS LOS LOS LOS LOS LOS LOS LOS LOS LO	1.2136			
LOCATION WAVENUMBER COT. DEPTH	LOCATION	VAVENUMBER	OPT. DEPTH	
1875 986 868687 774099425 94 1876 986 868741 73 3696 65 1877 986 869461 744039926 80 1878 986 814272 699685377 665 1878 986 814272 699777 695	Outrest eases ease eases ease eases eases eases eas ea	986.651259 986.656888 986.658741 986.5658181	.18928336E-#3 .14229546E-#3 .18942459E-#3 .84293485E-#4	
33 9#6. 67#49#7 . 54#7#7#6#32F-64 34 98%	7/4/4 USWSS MUDST	989.919259 989.981828 989.988741 989.993481	.25763877E-84 .36753292E-84 .3781874E-84 .47687442E-84	
THE THE CONVOLUTION PAREL 1823 . 9 . 94. 94. 94. 94. 94. 94. 94. 94. 9				
TACAR . AVERAGE ZETA = .928	3. NO. LINES	AFTER REJECT	- 133, NO.	HU CHANGES - 9
AEP TEST CASE - MULTIPLE SCATTERING - RURAL AEROSOL * 988 - 918 CM-1	FASCOD2	86/87/15 16	.04.54	
THE TIME AT THE START OF PAUREG IS 75.296				
: vifial Lave? I Final Liver 8 File 12 Minder Tu si F II ONTO FILE 12 CHTRL AND LAM? # 1 I I ONTO FILE 12				
LOCATION WAVENUMBED PADIANCE TRANSMITTANCE	LOCATION	VÄVENUMBER	RADIANCE	TRAKSELTTARCE
9ff.£7888? .9786624£ B6 .85628837£+#8	1484	986.651259	.958 <i>8</i> 577 <i>8</i> E- <b>8</b> 6	.0351#853€+#8

	.8426823E+00 .84258587E+00 .84257672E+00 .8425533E+00 .13289592E-01 .13273446E-01 .13273446E-01	.885739816-06 .888753806-06 .888771416-06 .8887771416-06 .293625316-04 .293625316-04 .2936269976-04	989.979259 989.984.888 989.993.481 989.993.29 989.979259 989.983.481 989.993.481	690 699 783 782 782 781 781		993405475-86 10060133E-85 10223497E-05 10439311E-85 10719060E-85 29466535E-94 29465538E-94 29445567E-94	1 986.674963 .99340547E- 3 986.674963 .99340547E- 3 986.684444 .18223497E- 4 986.689185 .18423311E- 5 986.63926 .18719868E- 2 986.674963 .29466535E- 2 986.674963 .2946653E- 4 986.689185 .29445567E- 5 986.689185 .29445567E- 5 986.69336 .29445567E-	) ( ( ( ( ( ( ( ( ( ( ( ( ( ( ( ( (
	.843Ø174ØE+ØØ .8426Ø223E+ØØ	.88573981E-06 .88871123E-06	969.979259 989.984888	693 693	• •	.99340547E-86 .10060193E-85	986.674963 986.679784	2 1
	.1282522E-@1	.29469911E-04	986.678222	14.08	.13338211E-81	.299339456-84	988.018963	ις.
	.128776#5E-Ø1 .128645#1E-Ø1 .12847642E-Ø1	.29473848E-84 .29473848E-84 .29471958E-84	986.656 <i>888</i> 986.668741 986.665481	1405 1406 1407	.13338454E-01 .13338395E-01 .13338312E-01	.29933962E-84 .29933962E-84 .29933956E-84	988.884741 988.889481 988.814222	N W →
	.12887323E-Ø1	.294738146-84	906.651259	1404	.13338483E-81	.299339568-04	989.808608	_4
5	COMP REFLECT UP	COMP FLUX UP	WAVENUMBER	LOCATION	COMP REFLECT UP	COMP FLUX UP	WAVENUMBER	LOCATION
	.83253651E+BB	.983435206-06	986.670222	1408	.85627899E+88	.79715827£-06	580.018963	ın.
	.83338414E+88	.36870217E-86	906.660741	1486	.85627698E+93 .85627415E+88	.79718337E-85 .79718337E-85 .79712958E-86	988.809481 988.809481 908.814222	N 65 4

LBLF4 "  LBLF4 "  LBLF4 "  LBLF4 "  LBLF4 "  LBCR LBLF4 "  Times Berial Courty of the	■ S N S S S S S S S S S S S S S S S S S	DVR4 = 0 02 02 02 02 02 02 02 02 02 02 02 02 0	H2O(T), CO2, NZ OZ(1508CM-1) A4 " .3834! BOUND FOR A71. NO EEAD CONVOLU B26 B36388E-85 B36388E-85 B36388E-85 B36388E-85 B37812E-85 B37812E-85 B37812E-85 B37812E-85 B37812E-85 B37812E-85 B3787812E-85 B37813E-85 B37813E-85		13. 11. 12. 13. 13. 13. 13. 13. 13. 13. 13. 13. 13	6 SELF HAS BEEP *****  80UNDF3(CM-1)	N REDUCED  NO. LINES  NO. LINES  LOCATION  2428 2428 2428 2431 2432 2433 2433 2433 4443 4443 4443	88 88 88 88 88 88 88 88 88 88 88 88 88	CM-1 REG10N  1. DEPTH  1. B	(B) SEPT 1985)	ŷn
T11	199	READ .012	CONVC	CONVOLUTION . 836	P A 2 C C C C C C C C C C C C C C C C C C						
AVERAGE WIDT		7 .807145. AVI	7 HALF WI	7 HALF VIDTH CHANGES VERAGE ZETA 878988	z.	.118.	NO. LINES	AFTER REJECT	* 110. NO. HW	CHANGES .	^
AER TEST CA	CASE - MULTIPLE		SCATTERING -	- RURAL AERCSOL	816 - 886 <b>.</b>	C#-1	FASCOD2	86/87/15 16	.84.54		
THE TIME AT INITIAL LAVE	THE STAR	OF RAD	MRG 1S	75.913							

AER TEST CASE - MULTIPLE SCATTERING - RURAL AEROSOL \* 986

LOCATION WAVENUMBER RADIANCE TRANSMITTANG	1484 993.325638 .78781928E-86 .85654195E+88	1485 983.328888 ,78776766E-86 ,85654778E+88 1486 983.338378 ,78772295E-86 ,85655189E+88 1487 \$83.332741 ,78768388E-86 ,85655465E+88	1408 903.335111 .78764977E-06 .85655625E+##	LOCATION WAVENUMBER COMP FLUX UP COMP REFLECT	1484 983,325638 ,29776857E-84 ,13438868E-8	1405 903.328000 .29776101E-04 .13439213E-01 1406 903.330370 .29776128E-04 .13439780E-01 1407 903.332741 .29776145E-04 .13440507E-01	1408 903,335111 ,29776155E-04 ,33441368E-8]	2396 989.814519 ,7419813ME-85 ,11659832E+88 2397 989.816889 ,72781287E-85 ,13114517E+88	2398 989.019259 .71168485E-05 .14630885E+ <b>08</b> 2399 989.021630 .59617926E-05 .16182887E+ <b>08</b> 2480 989.024000 .68075892E-05 .17745863E+ <b>08</b>	2396 989.814519 .28719149E-84 .41151476E-83 2397 989.816889 .22146717E-84 .53716889E-83 2398 989.819259 .23645375E-84 .67856671E-83	2399 989.821638 .25688981E-04 .82488868E- <b>83</b> 2488 989.824888 .25986981E-04 .9558566E- <b>83</b>	488 989.991111 .88981445E-86 .84246264E+88	489 989.993481 .889818586-86 .842468718+88 418 989.995862 .889823758-86 .842458298+898 411 909.998222 .889838938-86 .842454938-98	412 918.888553 .889848995-86 .842458235+8#	408 909.99111 29358745E-04 13266218E-09 909.993481 29356691E-04 13266104E-09	418 989.995852 .29358624E-84 .13265972E-8 411 989.99822 .29358531E-84 .13265789E-8 412 918.888593 .29358481E-64 .13255532E-8	
TRANSMITTANCE	.8561864ØE+8Ø	.8561 <i>86842+98</i> .85618535E+ <i>98</i> .85618444E+ <i>28</i>	.85618332E+ØØ	COMP REFLECT UP	.13333891E-Ø1	.1333389E-Ø1 .13333876E-Ø1 .13333854E-Ø1	.13333824E-Øl	.85655657 <b>E+88</b> .856556 <b>8</b> 5E+ <b>8</b> 8	.8565546 <i>0E+89</i> .85655235E+88 .85654934E+88	.13442347E-81 .13443451E-81 .13444655E-81	,13445944E-81 ,13447313E-01	.19314697E+8B	.2.875124E+00 .2.129957E+80 .2.3.79460E+00	.25517#24E+8#	.11086554E-82 .12278638E-02	.13511 <i>8</i> 54E- <i>0</i> 2 .14786184E- <i>0</i> 2 .1688831E- <i>8</i> 2	
RADIANCE	.79727294E-86	.79727874E-86 .79728742E-86 .79729761E-86	.79730924E-06	COMP FLUX UP	.29931377E-84	.29931384E-84 .29931398E-84 .29931393E-84	.29931394E-#4	.78762Ø85E-Ø5 .78759618E-Ø6	.7875567E-#5 .78755885E-#5 .78754558E-#6	.29776153E-84 .29776149E-84 .29776139E-84	.29776122E-84	. 665454456-85	.658487478-85 .63554784E-85 .62885273E-85	. 68632198E-85	.26659#25E-#4 .26932991E-#4	.27838848E-84 .27838848E-84 .27817522E-84	
WAVENUMBER	968.88688	966.882378 966.884741 968.887111	988.881	WAVENUMBER	900.00000	988.882378 988.884741 988.887111	980.889481	983.337481 983.339852	903.342222 903.344593 903.346963	9Ø3.337481 9Ø3.339852 9Ø3.342222	903.344593 903.346963	983.826378	983.828741 989.831111 989.833431	989.835852	989.826378 989.828741	989.831111 989.833481 989.835852	
LOCATION	-	ผพจ	ហ	LOCATION	~	ผพส	ស	10	ഗഷസ	-06	<b>*</b> ₩	-	ಬಣಕ	νn	- 2	w≉w	

12 ONTO FILE

			02(1688CM-1), 03(DIFFUSE,T), H20 SELF HAS BEEN REDUCED IN THE 883-1200 CM-1 REGION (81 SEPT 1985)
			# EC 1
. 54			CM-1
16.84			-120A
/15			E 883
86/87			H H
SC002			REDUCED
3			BEEN
CM-1			HAS
918			SELF
- 898			. H20
CATTERING - RURAL AEROSOL * 988 - 918 CM-1 FASCOD2 86/87/15 16.84.54		H20(T), CO2, N2 (#1 3ULY 82)	O3(DIFFUSE.T)
- RUR		N2 (	-13.
SCATTERING		H20(T),C02,1	02(1688CM
PLE		tua:	
AER TEST CASE - MULTIPLE	69	********* CONTINUA:	
ASE -	-	*	
EST C.		* * * *	
AER T	LAYER	****	

SIGI ******	IPTS4 .	35	DVR.4		.28227	BOUND4 -	6.47269	*4***						
LBLF4 DV FOR LBLF	14 * LF4 *	.28227	27	BOUN	FOR TOR	BOUND FOR LBLF4 -	6.4727							
NO. LINES	. LINES BEFORE	SHR INK		7	441. M	NG. LINES AFTER		SHRINK - 2	288. N	NO. LINES	AFTER REJECT	• •	143	
*	TIME 76.688		READ . 824		CONVOLUTION	UTIO₩ .Ø56	Aq .	PANEL . BB1						
HIRACI OUTPUT ON FILE	AC1 FILE	1.0		2		.88158825		80UNDF3(CM-1)	- 1	4845			; f.	
LOCATION	WAVENUMBER	BER	OPT. DE	DEPTH					2	LOCATION	WAVENUMBER	OPT. DEPTH	# 1 H	
1825	986.886 988.881	<b>5888</b>	.12554139E-#6	139E-	9.6					2428	982.217886 982.218667	.28891019E-85	9E-#5	
1828	958.833		.18949777E-86 .18457647E-86	777E- 647E-	88 85 60			•				.4219961 .53886Ø1	4E-85	
1829	988.886	6321	.100948325-8	8326-	9.6					2432	902.223407	.69615145E-05	158-85	
E 61	982.224	4988 6568	.93863494E-Ø5	494E~	6.5					2428	586.889679 986.811259	.35344142E-R6	3E-86	
3 9 9 9	982.228 982.229		.172081	632E-	94							.3283679	18∑-#6  7£-#6	
37	982.231	3.89	.245293Ø1E-B	3Ø1E-	48					2432	906.816008	387556958	98-39	
00000 0400	946.417588 946.419168 946.828741 966.822321		.29875783E-86 .29839775E-86 .282874B8E-86 .27619896E-86	783E- 775E- 188E- 896E-	1986 1986 1986 1986 1986 1986 1986 1986					2428 2428 24329 2433	989.882272 989.883852 989.885432 989.887812	.99924859E-07 .99554126E-07 .9986£385E-07 .99986247E-07	596-87 566-87 356-87 176-87	
37	986.823	9.01	.27#35331£-#6	3316-	94					2432	989.888593	. 18817113E-86	.ae-86	
888 888 888 888 888 888 888 888 888 88	989.818173 989.811753 989.813333		.18873431E-#6 .18145824E-#6 .18228269E-86 .18323856E-#6	431E- 894E- 759E- 756E-	866 866 866 865					158 151 152	989,993481 989,995862 989,996642 989,99822	.86682498E-86 .10835428E-85 .11534512E-85	38E -86 28E -85 2E -85	
37	918.686	161	.18451685£-#6	- 3589	9.6					153	989.99882	.15449143E	135-85	
76	76.816		READ		CONVOLUTION . #31	UT10K	4	PANEL . #58						

183, NO. LINES AFTER REJECT \* 183, NO. HW CHANGES \*

4 HALF WIDTH CHANGES

	:			TRANSMITTANCE	.851 <i>02450</i> E+ <i>08</i> .85 <i>0</i> 934 <i>0</i> 2E+ <i>08</i> .85 <i>0</i> 84592E+ <i>08</i>	.85076012E+00	COMP REFLECT	.13284466E-81 .13288284E-81 .13196235E-81	.13192288E-01	.84147561E+ØB	.84136043E-03 .84123647E+09 .84110468E+00	.840966136+00	.13086416E-01	.13090235E-01 .13076729E-01 .13072997E-01	.83752952E+88 .83739263E+88 .83715874E+88	.8367856+88	.131148865-81	. 13185834E-@1 . 13895117E-@1 . 13887389E-81	.13878669E-81	.842443135 · 8B
. #4.54				RADIANCE	.83228231E-86 .83228234E-86 .83272127E-86	.83321259E-06 .83367587E-06	COMP FLUX UP	.29795517E-84 .29794486E-84 .29793329E-84	.29792148E-04 .297918947E-04	.90857094E-06	.909662796-06 .910827146-06 .912056246-06	.9133/1216-86	.29543511E-84	.295431365-84 .295429755-84 .2954.7756-84	.932823735-86 .933921586-66 .93578674E-85	.93937286E-86	.2934Ø62BE-Ø4	.29337783 <b>E-84</b> .29337783 <b>E-84</b> .29336361E-84	.29334951E-84	. 989 <b>256</b> 2725-46 . 889 <b>25</b> 9546-46
86/87/15 15		,	i	WAVENUMBER	982.217886 982.218667 982.228247	982.221827 902.223487	WAVENUMBER	982.217886 982.218667 982.228247	982.221827 982.223487	986.009679	906.011259 906.012840 906.014420	986.816888	986.889679 986.811259	926.212848 926.214428 936.216888	909.802272 909.803852 909.805432	909.807012 909.808593	989.882272	909.863852 909.805432 909.807012	909.808593	989.993481
FASCOJ2				LOCATION	1484 1485 1486	1407	LOCATION	1484 1485 1486	1467	2396	2397 2398 2399	2488	2396 2397	2398 2399 2488	2396 2397 2398	2399	2396	2397 2398 2399	2488	117
RURAL AEROSOL " 988 - 918 CM-1	75.829		O F1LE 12	TRANS'II TTANCE	85617046E+\$\$ 85617027E+\$\$ 85616992E+\$\$	.85616943E+00 .85616885E+00	COMP REFLECT UP	.133329#\$E-#1 .1333296#E-#1 .133329##E-#1	.13332891E-Ø1 .13532877E-Ø1	.85 <b>859627E+BB</b>	85851972E+86 85844998E+80 85839297E+88	.85035531E+00	.13184788E-81 .13181158E-81	13177921E-01 13175346E-01 13173825E-01	.84082274E+88 .8406725BE+88 .8495]454E+88	.840347592+88 .848171"1E+A8	.138691#7E-#1	.13Ø54991E-Ø1 .13Ø68614E-Ø1 .13Ø5595ØE-Ø1	132589878-81	.83628389E+88
IPLE SCATTERING -	OF RADMRG 1S	INAL LAYER 18	FILE 11 ONT	RADIANCE	.79738801E-86 .79731139E-86 .79731642E-86	.79732245E-86	COMP FLUX UP	.29938878E-84 .29938874E-84 .29938879E-84	.29930883E-04	.83411Ø56E-Ø6	.83451276E-86 .83487603E-86 .83518655E-86	.835429085-06	.23789716E-04 .29788497E-04	.29787358E-04 .29786461E-84 .29786815E-84	.914665881-86 .91684758E-86 .91749586E-86	.91901685E-06 .92061503E-06	.29542459£-84	.295428756+84 .29541648E-84 .29541163E-84	.295486356-84	.94186575E-86
CASE - MULTI	AT THE START	AYER 1 F	C MERGED WITH	WAVENUMBER	988.881588 988.881588	900.004741 909.006321	VAVENUMBER	988.888888 988.881589 988.883168	388.884741 988.586321	982.224988	902.226568 902.228148 902.229728	902.231309	902.224988 902.226568	982.228148 982.229728 982.231309	906.017588 906.019168 905.020741	986.822321 986.823981	986.817588	986.919:68 986.828741 986.822321	986.823981	909.810173
AER TEST (	SWIF SKE	INITIAL LA	FILE 16	LOCATION	el (4th	4 fù	LOCAT:ON	-NM	ৰ দ		N € 4	5	7	m <del>u</del> v	~ <b>r</b> ın	₹ kū	v-4	N M 🗪	ເກ	- 2

				77.452	THE TIME AT THE END OF RADMRG IS 17.452	AT THE END O	THE TIME
.13264536E-#1	949,998222 .29357893E-84 .13264536E-21 989,999882 .29357887E-24 .13264524E-91	989.998222 989.999882	128	.138465975-81 .13839525E-81	.29329551E-#A .13#46597E-#1 .29328281E-#A .13#39525E-#1	9.89.814914 9.79.816494	At RU
.13265884E-81 .13264913E-81	989.993481 .293581386-84 .132658846-81 989.995862 .293588846-84 .132649136-81 989.996642 .293588286-84 .132648826-81	989.993481 989.995862 989.996642	117	.13878273E-#1 .13862149E-#1 .13854385E-#1	.2933566E-#4 .13878273E-#1 .29332289E-#4 .13862149E-#1 .29338976E-#4 .138543#5E-#1	989.818173 989.811753 989.813333	<b>- ∨</b> €
.84243948E+88 .84243462E+88 .84243443E+88	929.996642 .88986383E.#6 .842.3948E.#87 989.998222 .88987422E.#6 .84243462E.#88 989.9998#2 .88987462E.#6 .84243443E.#8		128	.83698537E+00 .8356966E+00 .63572059E+00	.94420954E-MS .836M8537E-MW .94564857E-KG .83559666E+WW .946980M9E-MG .83572M59E+MW	589.813333 989.814914 989.816494	ല⊀സ

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COMPETECT	. 565666666 + 55 . 56566666 + 55 . 33566666 + 55	. 88938885 + 68 . 88438885 + 68	TOTAL FLUX DN	. 888888888 + 1919 . 888888888 + 1919 . 8888888 + 1919 . 888888 + 1919	. 88888888 + 88 . 89588888 + 88 . 89688888 + 88	. 89888888E+\$\$ . 888888E+\$\$ . 8888888E+\$\$	62866666 6886666 6886666 6886666	. Sebsesete	. 5755555555545 . 1355555555545 . 5755555555455 . 575555555	. 2000000000000000000000000000000000000	CCBBBBBE:+8 8888886:+8 8888886:+8	. 89388835.488 . 99888885.486 . 93888865.486 . 83888886.486
XOL FUNDAMENTAL STATE OF THE PARTY OF THE PA	.68687836E-89 .78659578E-89 .73178991E-89	.76899757 <b>2-89</b> .819876 <b>655-89</b>	TOTAL FLUX UP	.29795617E-#4 .29793329E-#4 .29793148E-#4	.62346228E-89 .62385249E-89 .62267,36E-89	.62232591E-09 .62201497E-09 .29543549E-04	295429136E-86 29542975E-86 29542775E-8	64886	.62364978E-#9 .62364685E-#9 .62364828E-#9	.29348628E-84 .29339288E-84 .29337783E-84 .29336361E-84	488885E-8 5236273E-8 5784329E-8	.66224576E-89 .66927481E-89 .29358138E-84 .2935884E-84
	982,217£86 982,218667 982,228247	982.221827 982.223487	VENUMBER	982.217886 982.219667 982.228247 982.22:827	982.223487 986.889679 986.811259 986.812848	986.814428 986.816288 986.889679 986.8119559	86.81284. 86.814421	.88227	989.883852 989.887812 989.887812 989.886593	589,883852 989,883852 989,885432 989,887812	89.99348 89.99586	989.998222 989.993882 989.993481 989.995862
Location	1484	1487	LOCATION	1485 1485 1486	1488 2396 2397 2398	2399 2396 2396	66.8	39	23399 23399 48998	23998 23998 23998 23998	===	121 121 121 1121 113

77.588	COMP REFLECT DN	,在我们的现在分词。 ,我们是我们的现在不会会。 ,我们是我们的现在不会会。	. Becondede + 66 . Becoebee + 68	TOTAL FLUX DM	. 80 P P B B B B E + 58 . 888 B B B B E + 88 . 888 B B B B B E + 88 . 888 B B B B B E + 88	. 886888885+88	. BEEREERES SE + 65 . BEEREERS SE + 26 . PSESEBBEERE + 66	. <i>BBBBBBB</i> E+BB . BBBBBBBE+BB	. 68868888E+68	. 89998856. •33 . 86998865. •88 . 8699888E • 88	. Besesese+Be	. 88888888 = 48 . 69888888 = 48 . 69889888 = 46 . 89889888 = 46	. 898999995+98 . 99899995+98 . 998959985+98 . 69869774E+98	0888886C+8 0888886C+8 0808886E+8	. BEBEBBBE + BB . BEBBBBBE + BB	. 66666666E+46	. 医多种种的多种种的 1000 1000 1000 1000 1000 1000 1000 1
F FLXDVH 1	COMP FLUX DN	.59189586E-89 .59159678E-89 .59138178E-89	.59122422E-09	TOTAL TLUX UP	. 2993@87@E-@4 . 2993@874E-@4 . 2993@879E-#4	.29938885E-£4	.8965832ÆE-#9 .99982727E-#9 .11455389E-#8	.13#8115#E-#8 .137853#1E-#8	.29789716E-#4 .29783497E-#4	.29787358E-#4 .29786461E-#4 .29786#15E-#4	.6219#959E-#9	.62148872E-#9 .62148872E-#9 .62181389E-#9	. 29542459E-64 . 29542875E-64 . 29541648E-64 . 29541163E-64	2415261E-B 2417498E-B 2428899E-8	.62423#6#E-#9 .62427#79E-#9	.29333566E-84 .29332289E-84	.29338876E-#4
T THE START	LAVER 18 VI	988.880888 988.881588 988.87168	988.884741 988.886321	WAVENUMBER	988.800688 988.881588 986.883168 988.884741	9BE.B86321	902.226568 902.226568 902.228148	982.229728 582.231389	982.224988 982.226568	982.228148 982.229728 982.231389	986.817588	906.019168 906.020741 906.022321 906.023301	99898	9.81817 9.81175 9.81333	929.814914 989.816494	909.810173 909.811753	989.813333
¥ F	LXDVN -	er éaro	<b>→</b> tu	CCATION	es to to a	Ŋ	- NM	<b>4</b> ₪	~11	⇔w		ពល⊲ហេ	<b></b> ∨1074 .	n –ve	<b>-</b> ₩ ເກ	<b>-</b> 2	m

CATION COMP FLUX DN COMP RELECT DN 1486 983.328888 367343468E-88 43344766E-86 1486 983.332741 3673226E-88 43344765E-86 1486 983.332741 36732651E-88 43344767E-86 983.332741 29776186E-84 36863487E-88 1486 983.332741 29776186E-84 36863487E-88 33387794794794794794794794794794794794794794
### COMP FLUX DN COMP REFLECT
COMP FLUX DN COMP REFLECT 3673436362-86 367343636-88 433447666-86 367326516-88 433447676-86 367326516-88 433447676-86 367326516-88 433447676-86 367326516-88 433447676-86 367326516-88 3673265176-88 367326-88 368634876-88 367326-88 368634876-88 367326-88 368634876-88 367326-88 368634876-88 367326-88 368634876-88 36864876-88 36864876-88 36864876-88 36864876-88 36864876-88 36864876-8
### REFLECT

, <b>建筑的建筑设置</b> 上,有位 ,现在建筑的现在时下,在在	•	COMP REFLECT DN	.433717116-86	.433717345-86 .433717485-86 .433717455-86	TOTAL FLUX DM	.36243218E-#8 .36188686E-#8	.36153712E-#8 .36128#48E-#8 .3611#889E-#8	.43379118E-86 .43379118E-86 .43379118E-86	.43379118E-#6	.36918884E-88	.36918894E-88 .36918994E-88 .36919175E-88	.36919427E-BB	.43425764E-86 .4342578BE-86	.434258#8E-#6 .434258#8E-#6 .43425821E-#6	.38979#59E-#8 .38916176E-#8 .38859#4#E-#8	.38758779E-88
.29329551E-64	TH 3 PANELS	COMP FLUX DN	.36113488E-E8 .36858868E-\$8	.36#23894E-#8 .35998231E-#8 .35981#71E-#8	TOTAL FLUX UP	. 29931425E-#4 . 29931433E-#4	.299314318-84 .29931441E-84 .29931442E-#4	.36789718E-#8 .36789727E-#8 .36789828E-#8	.36798889E-88	.297762#3E-#4	.29776199E-84 .29776188E-84 .29776172E-84	.29776149E-#4	.38863290E-08	.38541783E-#8 .38689639E-#8 .38641453E-#8	.26659829E-#4 .26932996E-#4 .27#81686E-#4	.27#38#46E-#4
589.814914 989.816494	LAYER 9 VI	WAVENUMBER	982.688888 988.682378	988.88741 988.887111 988.889481	WAVENUMBER	986.66666 986.862378	988.884741 988.887111 988.889481	983.337481 983.339852 983.312222	983.344533 983.346963	903.337481	983.342222 983.342222 983.344593	383.346963	989.826378 989.828741	989.831111 989.833481 989.835852	969.82637 <i>6</i> 969.828741 969.831111	9#9.#33481 9#9.#35852
<b>⊲</b> un	FLXDVN -	LOCATION	12	ოძი	LOCATION	- 2	ក្នុស	rum	<b>→</b> 10	-	64 ES	ស	~ t4	62 A 70	- NO	<b>₩</b> 10

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	MS TRANS	.99997843E+00 .99997781E+00 .99997702E+00	.99997585E+## .39997427E+##	.99398823E+88	.99998825 <u>E</u> +88 .99998826E+88 .99998827E+98	.93998#28E+8#	.99998884E+88	.99998884E+88 .995988884E+88 .999988884E+	.99997926E+BB .99997912E+BB .99997897E+BB	.99997888E+##			COMP REFLECT	.98752986E-86	.98776572E-#6 .98783528E-#6 .98788364E-#6	TOTAL FLUX DM	.157@#911E-#7 .13322#97E-#7	.11842112E-87 .18817819E-87 .:8114793E-87	.98985627E-Ø6 .9898428ØE-Ø6
udu, gaze	. Fee	.48384544E-12 .48383171E-12 .48381818E-12	. 40380481E-12	.40064191E-12	.48863862E-12 .48863622E-12 .48863488E-12	. 488631256-12	.39832113E-12 .3983Ø18ØE-12	.39828241E-12 .39826328E-12 .39824482E-12	.39868338E-12 .39868314E-12 .39868285E-12	.398682Ø5E-12 .39868215E-12			COMP FLUX DN	.156718Ø5E-Ø7 .13292987E-Ø7	.11812993E-87 .18787986E-87 .18885688E-87	TOTAL FLUK UP	.29473216E-84 .29473623E-84	.29473268E-84 .29472819E-84 .29478749E-84	.8625-144E-08
	VAVENUMBER	9#2.217#86 9#2.218667 9#2.22#247	902.221827 902.223407	986.889679	906.011259 906.012848 986.814428	986.816888	909.802272 909.803852	989.885432 989.887812 989.868593	989.993481 989.995862 989.996642	989.998222 989.9998&2			WAVENUMBER	986.651259 986.656888	986.668741 986.665481 986.678222	WAVENUMBER	986.651259 986.656888	986.668741 986.665481 986.678222	989.979259 989.98 <b>4888</b>
orionia State of Anna Dia	LOCATION	1484 1485 1486	1487	9682	2397 2398 2399	2488	2396	2398 2399 2488	1118	128			LOCATION	1484	14.06	LOCATION	1484	14.86 14.87 14.88	8 66 6 69 7
											•								
		<b>6</b> 2 63 53	තුල	6.	5 5 5	8	ba ba	<i>2</i> 0 <i>2</i> 0 <i>2</i> 0	80 80 80	<b>8</b> 1 63			. NO	<b>y</b> o y <b>o</b>	20 <u>20 30</u>	z	<b>80</b> 80	\$0 \$0 <b>\$0</b>	<b>20</b> 20
78.468	MS TRANS	.9999815#E+## .99998151E+## .99998152E+##	.99998152E+00 .99998153E+00	.99997183E+88	.99996859E+## .999964#1E+0# .99995915E+0#	.99995669E+88	.99998 <i>8</i> 29E+8 <i>B</i> .99998 <i>8</i> 29E+8 <i>B</i>	. 99998#328£+8# . 99998#338£+8# . 99998#31£+##	.99998882E+88 .99998882E+88 .9999888E+	.99998882E+88 .99998887E+88	79,785 IS MERGE			.98689030E-06 .98689144E-06	,98689224E-86 .98689278E-86 .98689297E-86	TOTAL FLUX DM	.76844215E-88 .75845842E-88	.75721656E-88 .75658871E-88 .75618982E-88	.9883656 <i>0</i> E- <i>0</i> 6 .98838865E- <i>0</i> 6
OF SRCFCN 1S 78.46	4 PANELS SCAT SRC FCN MS TRAN	9999815#E+# 99998151E+# 99998152E+#	99998152E+Ø 99998153E+Ø	9997183E+B	99996859E+8 999964Ø1E+8 99995915E+8	B+3699666	9998 <i>8</i> 28E+8 9998 <i>8</i> 29E+8	9998838E+8 9998838E+8 9998831E+8	999988882E+8 999988882E+8 99998888	99998BBZE+B	F SRCFCN IS 79.78 REGUIRED FOR THIS MERGE	TH 2 PANELS	MP REFLECT D	98689030E-0	98689224E-B  98689278E-B  98689297E-B	AL FLUX D	76844215E-8 75845842E-8	75721656E-B 75658871E-B 75618982E-B	9883656ØE-Ø 98838865E-Ø
E START OF SRCFCN IS 78.46	PANELS SRC FCN MS TRAN	3627E-12 .9999815#E+# 363#E-12 .99998151E+# 3635E-12 .99998152E+#	40583638E-12 .99998152E+0 40583640E-12 .99998153E+0	40400495E-12 .99997183E+8	42399349E-12 .99996859E+# 40398331E-12 .999964Ø1E+0 40397568E-12 .99995915E+0	97158E-12 .9995669E+8	48888888888888888888888888888888888888	48878322E-12 .99998838E+8 48878322E-12 .99998831E+8 48877886E-12 .99998831E+8	39834788E-12 .99998882E+8 3983284E-12 .99998882E+8 39831&61E-12 .99998882E+8	39829256E-12 .99998002E+0	SRCFCN IS 79.78 FOUTE OF THIS MERGE	ANEL	FLUX DN COMP REFLECT D	5748798E-Ø8 .98689030E-Ø 5550626E-Ø8 .98689144E-Ø	:6239E-88 ,98689224E-88 :5454E-88 ,98689278E-88 :5485E-£8 ,98689297E-8	OTAL FLUX UP TOTAL FLUX D	29934 <i>8</i> 58E- <i>8</i> 4 .76 <b>844215E-8</b> 29934 <i>8</i> 63E- <i>8</i> 4 .75845 <i>8</i> 42E- <i>8</i>	29934863E-84 .75721656E-8 29934857E-84 .75658871E-8 29934846E-84 .75618982E-8	96848872E-88 .98836568E-8 92883619E-88 .98838865E-8

.9884#659E-#6	.98841971E-#6	.963793116-88	.93694817E-#8 .9#593#2#E-#8 .8875633#E-#8	
.9#3#1884E-#9	.88465283E-#8 .871714#8E-#8	.29466658E-84	.29451857E-#4 .294551855-#4 .20**5688E-#4	
986.68444	9#6.689185 9#6.693926	986.674963	926.679784 986.68444 986.689100	70000
m	₹19	-	01 m -4	

989.979259

		MS TRANS	.99988833E+88 .99988833E+88 .99988934E+88	.99988834E+ <i>BB</i> .9998834E+& <i>B</i>	.999878482+80	.99987911E+888 .99987911E+888 .99987942E+88	.99987978€+88	.99987287E+68 .99966978E+68	99986591E+88 99986292E+88 99985733E+88				MS TRANS	99997843E+ØØ	.99997781E+88 .99997782E+88 .99997585E+88	99997427E+88	99998023E+00 99998025E+00	99998#26£+#8 99998#27E+#8 99998#28E+##	99998 <b>884E+88</b> 99998 <b>884E+88</b>	99998 <b>884E+88</b> 99998 <b>884E+8</b> 8	99397926E+ØØ	99997912E+80
		MSCAT SRC FON	23481275E-11 . 23481231E-11 .	.23481244E-11	16364615E-11	.17491729E-11 .18674989E-11 .19745386E-1	205237966-11	232#311#E-11 .	.23203189E-11 .23203214E-11				MS EMISSION	2754Ø892E-11	.27548135E-11 . .27539416E-11 . .27538748E-11 .	275381366-11	27328239E-11 .	273280946-11 273279356-11 273277396-11	.27152487E-11 . .27151887E-11 . .27149763E-11 .	.2714946#E-11 .	. 27189458E-11	2718948BE-11 2718965BE-11
		WAVENUMBER	963.325638 983.328888 983.338378	903.332741	989.914519	989.816889 989.819259 989.821638	989.824BBB	989.991111 989.993481	989.995852 989.998222 918.888593				WAVENUMBER	902.217086	9#2.218667 9#2.22#247 9#2.221827	982.223487	986.889679 986.811259	986.812848 986.814428 986.815888	9#9.8#2272 9#9.8#3852 9#9.8#5432	989.887812	9.09.393481	989,995862 989,996642
		LOCATION	1484 1485 1486	1487	2396	2397 2398 2399	2488	4 68 8 4 68 9	418 411 412			-2.5088	LOCATION	1454	1405 1406 1487	1408	2396 2397	2398 2399 2499	2396 2397 2398	2399 2488	117	118
79.998		MS TRANS	.9998988987E+88 .99989115E+88 .99989127E+88	.99989136E+80 .99989141E+80	.99988813E+Ø®	.99988813E+88 .99988813E+88 .99988813E+88	.99988812E+##	.39587977E+88 .99987999E+88	.99983819E+89 .99988875E+88 .99988851E+88	88.832		O FILE 28 WITH XTVPE-	MS TRANS	.9999815BE+BB	.99998151E+BB .99998152E+BB .99998152E+BB	.99998153E+BB	.99997183E+ØØ .99996859E+ØØ	.999964815+88 99995915E+88 99995669E+88	.9998&Z28E+&& .9999&&Z9E+&@ .9999&&Z9E+&	.99998 <i>030</i> E+00 .99998 <i>0</i> 31E+00	.99998002E+BB	.99998882E+88 .999988882E+88
OF SRCFCN IS	TH 3 PANELS	MSCAT SRC FCN	.23617228E-11 .23617228E-11 .23617227E-11	.33617225E-11 .23617223E-11	.234399Ø4E-11	.23499981E-11 .23499893E-11 .33499888E-11	.23499862E-11	.21281897E-11	.21335306E-11 .21363982E-11 .21347730E-11	OF MSEMIS IS	FINAL LAYER 18	FILE 26 ONT	MS EMISSION	.276751486-11	.27675149E-11 .27675149E-11 .27675149E-11	.27675149E-11	.27539893E-11 .2753947@E-11	.275391Ø5E-11 .27538838E-11 .27538712E-11	.27329176E-11 .27328815E-11 .273284Ø3E-11	.27327952E-11	.27147884E-11	.27145842E-11
THE TIME AT THE START	SRCFCH - LAYER 9 WITH	LOCATION WAVENUMBER	1 988.288888 2 988.882378 3 988.884741	4 908,RR7111 5 989,R09481	1 903.337481	2 903.339852 3 903.34222 4 903.344593	5 983.346963	1 909.62637 <i>8</i> 2 909.628741	3 989.831111 4 989.833481 5 989.835852	THE TIME AT THE START	INITIAL LAYER 1 F	FILE 27 MERGED WITH	LOCATION WAVENUMBER	ា 988.888888	2 900.001588 3 900.003160 4 900.004741	5 900.00632:	1 902.224988 2 902.226568	3 982,228148 4 962,229728 5 972,231389	1 986.817588 2 986.819168 3 986.828741	4 986.822321 5 986.823981	1 909.810173	2 909.811753 3 909.813333

120 989.9982222  -27142214E-11 .99998082E+88	. 99397888E • BB	.99997858E+##				COMP REFLECT DN	.98964 <i>8</i> 98E- <i>8</i> 6 .9896 <i>8</i> 959E- <i>8</i> 6	.989565 <i>848</i> 1E-86 .9895 <i>8</i> 4481E-86 .98948398E-86	TOTAL FLUX DM	.1 <i>8</i> 587727 <i>E-8</i> 7 .1 <i>8</i> 9354 <i>8</i> 9E- <i>8</i> 7	.11438866E-#7 .12162751E-#7 .134841#5E-#7
2E+88 120 989.998222  LECT DW LOCATION WAVENUMBER 1483 989.968778  ZE-86 1484 989.968778  ZE-86 1485 989.96878  ZE-86 1485 989.984889  UX DN LOCATION WAVENUMBER 1487 989.994888  E-86 1487 989.994888  E-86 1487 989.994888  E-86 1487 989.9948888  E-86 1487 989.9948888  E-86 1487 989.9948888							.10554655E-07 .10985342E-07	.11489886E-87 .12133693E-87 .13375858E-87	TOTAL FLUX UP TOTAL FLUX DM	.29375498E-#4 .29371681E-#4	.29366487E-84 .29366259E-84 .29366825E-94
26 + 98 26 - 96 27 - 96 28 - 96 29 - 96 30 - 96 30 - 9						VAVENUMBER	989.969778 989.976889	989.984889 989.991111 989.998222	VAVENUMBER	989.969778 989.976889	989.984888 989.991111 989.998222
4 989.814914 .27143375E-11 .99998082E+88  5 989.816494 .27142214E-11 .99998082E+88  THE TIME AT THE END OF MSEMIS 1S 81.816  1.827 SECS WERE REQUIRED FOR THIS MERGE  I.827 SECS WERE REQUIRED FOR THIS MERGE  ELXDWH - LAYER 7 WITH 1 PANELS  LOCATION WAVENUMBER COMP FLUX DM COMP REFLECT DM  1 988.887111 .98635268-88 .9867362E-86  3 988.87111 .98635266E-88 .9867362E-86  5 988.87111 .98356732E-88 .9867362E-86  5 988.87111 .98356732E-88 .9867362E-86  5 988.87111 .29937114E-84 .91287239E-88  2 988.807111 .29937114E-84 .9838668E-88  3 988.807111 .29937114E-84 .9838668E-88  3 988.807111 .29937114E-84 .9838668E-88  4 988.807111 .29937114E-84 .9838668E-88  3 988.807111 .29937114E-84 .9838668E-88	120	121				LOCATION	14.83	1485 1486 1487	LOCATION	1483	1485
## 989.814914 .27142375E-11    5 989.816494 .27142214E-11   THE TIME AT THE END OF MSEMIS 1S   1.827 SECS WERE REQUIRED FOR TH   1.827 SECS WERE REGUIRED FOR TH   1.828 SECS WERE REQUIRED FOR TH   1.827 SECS WERE WERE WERE WERE WERE WERE WERE WER	.99998802E+88	.99998882E+88	81.816 15 MERGE	81.817 15 MERGE		COMP REFLECT DN	.98673132E-#6 .98673382E-#6	.98673527E-#6 .98673629E-#6 .98673629E-#6	TOTAL FLUX DN	.91287239E-#8 .9 <i>9</i> 93 <i>9</i> 668E-#8	.987458665*88 .98654338E-88 98657331E-88
# 989.814914  5 989.816494  THE TIME AT THE END OF 1.827 SECS WERE FILED OF 1.827 SECS WERE FILED OF 1.827 SECS WERE FILED OF 1.827 SECS WERE FILED OF 1.827 SECS WERE FILED OF 1.827 SECS WERE FILED OF 1.828 SECS WERE FILE	.27143375E-11	.271422146-11	EQUIRED FOR TH	SRCFCN IS		COMP FLUX DN	.90991840E-88	.90449666E-108 .90358930E-108 .90326732E-108	TOTAL FLUX UP	.29937114E-84	.29937895E-84 .29937874E-84
THE TIME THE TIME THE TIME 1.82 FLXDVN - LOCATION 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	909.814914	989.816494	AT THE END OF	AT THE END OF	LAYER 7 WT	VAVENUMBER	988.888888 988.887111	988.814222 988.821333 988.828444		988.809800 988.807111	988.814222
	•	'n	THE TIME	THE TIME 1.82	FLXDVN -	LOCATION	<b>⊶</b> (1	ស∢ស	LOCATION	-0	लचा

		LOCATION WAVENUMBER MSCAT SRC FCN PS TRANS	1484 986.651259 .29521113E-11 .99967443E+88	1485 986.656888 .29518618E-11 .99972141E+88 1486 986.668741 .29516389E-11 .99975427E+88 1487 986.665481 .2951383E-11 .99977929E+88	1408 906.670222 .29510088E-11 .99979700E+80	698 909.979259 .29460554E-11 .99383526E+008 699 909.984000 .29457352E-11 .99983027E+00	788 989.988741 .29457249E-11 .99982325E+80 701 905.993481 .29457667E-11 .99981334E+80 782 909.998222 .29458469E-11 .99979988E+80			-1.8963	LOCATION WAVENUMBER MS EMISSION MS TRANS	1484 982.217886 .57327788E-11 .99997843E+RB	14#5 9#2.218667 .5732647#E-11 .999977#1E+### 14#6 9#2.22#247 .5732534#E-11 .999977#2E+## 14#7 9#2.221#27 .57324375E-11 .999975#5E+###	1488 982.223487 .57323688E-11 .99997427E+88	2395 926.009679 .56924400E-11 .99998023E-00 2397 906.011259 .56924162E-11 .99990025E+00	2398 906.01284# .56923970E-11 .99998025E+00 2399 906.014420 .56923659E-11 .99998027E+00 2400 906.016000 .56923014E-11 .99998028E+00	2396 579,807272 .5658555E-11 .99998084E+80 2397 909.82.52 .56583013E-11 .99998004E+00 2398 909.805432 .56580786E-11 .99998004E+00	2399 909.807012 .56577543E-11 .99998004E+500 2400 909.8006593 .56574848E-11 .99998004E+20	117 909.993481 .56642050E-11 .99997926E+60	118 989.995862 .56642873E-11 .99997912E+88 119 989.996642 .56642233E-11 .99997898F+88 128 989.998222 .56642856E-11 .99997898E	121 909.999802 .56639858E-11 .99997858E+BB
81.161		MS TRANS	99986363E+##	99986428E+## 99986428E+## 99986445E+##	99986454E+##	99501933 <b>E+01</b> 99981787E+ <b>18</b>	99982#35E+#8 99982943E+#8 99933283E+#8	81.688		FILE 26 WITH XTVPE-	MS TRANS	99998158E+88	99998151 <b>E+88</b> 99998152E+88 99994152E+88	99998153E+8#	99997183 <b>6+88</b> 99996859 <b>E+8</b> 8	999954815+08 99995915E+08 99995669E+28	99998#28E+#8 99998#29E+#8 99998#29E+#8	999988382+## 99998831E+##	999988B25+8B	999984482E+88 99998467E+02 99998467E+86	99998002E+00
OF SRCFCN IS	H 2 PANELS	MSCAT SRC FCN	. 2991337#E-11	.29913353E-11 . .29913337E-11 . .29913321E-11	. 29913385E-11	.29538798E-11	.29518497E-11 . .29508679E-11 .	OF MSEMIS 15	FINAL LAVER 18	FILE 28 ONTO	MS EMISSION	.575847445-11	.57584743E-11 . .57584742E-11 .	.57584736E-11	.57325381E-11	.57324878E-11 57324958E-11 57325818E-11	.56922933E-11 .5692#8#8E-11 .56918767E-11 .	.56917602E-11 .	.56573414E-:1	.565/87878-11 .56568237E-11 .56565698E-11	.56563255E-11 .
AT THE START	- LAYER 8 VITH	N WAVENUMBER	988.88888	988.884741 988.889481 988.814222	988.018963	986.674963	926.689185 926.689185 926.693926	E AT THE START	LAVER 1 FI	27 MERGED VITH	N WAVENUMBER	១៥២.៥០៥.៥១៩	988.82:588 988.883168 988.884741	988.886321	582.224988 982.226568	982.229148 982.229728 982.231389	986.81,556 986.7,9156 986.82741	986.823321 986.823981	989.818173	989. F: 753 989. 6. 3333 989. 814914	989.816494
THE TIME	SRCFCN	LOCATION	7	เมตา	w	r4 F1	n <b>∢ v</b> n	THE TIME	INITIAL	FILE	LOCATION	-	12 m 44	ហ	~ (1)	n ≄ w	<b>37</b> €	w un		N to 4	'n

		LOCATION WAVENUMBER COMP FLUX DN COMP REFLECT DN	934 989,952888 .15412978E-#7 .285#644#E-#5 935 909,962667 .159#93274E-#7 .285#5#5733E-#5	936 989.973333 .16715744E-87 .28584565E-85 937 989.984878 .18134676E-87 .28582537E-85 938 989.994667 .287621522-87 .2849898E-85	LOCATION WAVENUMBER TOTAL FLUX UP TOTAL FLUX DN	934 989.952888 .29379766E-84 .15496721E-87 535 989.962667 .29378882E-84 .15987821E-87	936 989.973333 .29375368E-84 .16799477E-87 937 989.984888 .29368778E-04 .18218384E-87 938 989.994667 .29367228E-84 .29845846E-87
81.781 S MERGE		COMP REFLECT DN	.27566912E-#5 .27566965E-#5	.27566991E-85 .27566994E-85 .27566983E-85	FLUX UP TOTAL FLUX DN	.13291562E-#7 .13233931E-#7	.1321#66#E-#7 .132#71#3E-#7 .13215425E-#7
THE TIME AT THE END OF SRCFCN IS 81.781 .628 SECS WERE REQUIRED FOR THIS MERGE	H 1 PANELS	COMP FLUX DN	.:32£9£32E~£7 .131514£1E-67	.1312813#F-#7 .3312457#F-#7 .13132895#7	TOTAL FLUX UP	.29938#36E-#4 .29938#17E-#4	.29937985E-64 .29937939E-64 .29937878E-64
AT THE END OF	FLXDWN - LAVER 6 WITH	WAVENUMBER	968.818667	988.821333 988.832488 988.842667	LOCATION WAVENUMBER	968.888888 988.818667	988.821333 988.832888 988.842667
THE TIME &	FLXDWN - L	LOCATION	1 2	ന≖ഹ	LOCATION	-14	en ≪a Nu

TABLE B-2 (Cont.)

- KITTO -	CAVENDADO	ָר אַ ער אַ	0.3.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.	7011400		400	2
EOC # 201	10E0E3A#	מאר זיני	2	NOT : WOOT	WAVE NUMBER	٥ ۲	E C C
लदाण च	968.888888 986.867111 988.814222 988.821333	.38138568E-11 .38138478E-11 .38138418E-11 .38138362E-11	.99995972E+88 .99995996E+88 .99996812E+88 .9999682E+88	1403 1404 1405 1406	989.969778 989.976889 989.984 <i>0</i> 88 989.991111	.39218621E-11 .39214678E-11 .39364268E-11 .39365967E-11	.999941886+488 .999936256+88 .999929836+88
5	9B8.028444	.38138318E-11	.99995825€+88	1487	989.998222	.393678Ø3E-11	.99991058E+80
THE TIME	AT THE START	OF MSEMIS IS	82,199				
INITIAL L	LAYER 1 F	FINAL LAYER 18					
FILE	27 MERGED WIT	H FILE 26 ONTO	O FILE 28 WITH XTYPE-	78571			
LOCATION	WAVENUMBER	MS EMISSION	MS TRANS	LOCATION	WAVENUMBER	MS EMISSION	MS TRANS
- NO	988.006076 988.001580 988.883168	.95720985E-11 .95720972E-11 .95720955E-11	.99996150E+88 .99998151E+88 .99998152E+88	1464 1485 1486	982.217886 982.218667 982.228247	.95642573E-11 .95641698E-11 .35641641E-11	.99997843E+08 .99997781E+08 .94997782E+08
₩W	900.004741 900.00532:	.95720936E-11	.99998152E+ØØ .99998153E+VØ	1407	982.221827 982.2234£7	.95641979E-11	.99997585E+ØØ .99997427E+ØØ
-	902.224988	.95645596E-1:	.99997183E+08	2396	906.009679	.957505855-11	.99998823E+@&
rum ≠	902.226568 902.228148 902.229728	.9564642@E-1: .956471@7E-11 .95647849E-11	.99996859E+00 .99996401E+00 .99995915E+00	2397 2398 2399	986.811259 986.812848 986.814428	.95749985£-11 .95749311£-11 .95748635£-11	.99998825E+08 .99998826E+28 .99998827E+28
S	902.231309	.956482206-11	. 99995669E+ØØ	2488	986.816888	.957476865-11	.9999808288+308
7 7 7	906.017588 906.019168	.95746978E-11	.99998828E+88 .99998829E+88	2396 2397	989.882272 989.883852	.95761544E-11	.99998###E+## .93898##E+##
ന⊲ശ	986.828741 986.822321 986.823981	.95741492E-11 .95739597E-11 .95737816E-11	.999988838E+88 .99998833E+88 .99998831E+88	2398 2399 24 <i>68</i>	909.805432 909.807012 909.808593	.95752676E-11 .95748143E-11 .95743678E-11	. 99998884E+88 . 93998884E+88 . 99998884E
- 2 6	909.810173 909.811753 909.813333	.95748429E-11 .95736114E-11 .95731934E-11	.999980 <i>6</i> 2E+ <i>08</i> .99998602E+ <i>88</i> .99998602E+ <i>8</i> 6	117 118 119	989.993481 989.995862 989.996642	.96884871E-11 .96884388E-11 .96884778E-11	.99997926E+ <b>88</b> .99997912E+ <b>88</b> .99997897E+ <b>38</b>
a≱ Nu	989.814914 989.816494	.95727800E-11	.99998002E+80	12.8	989.998222 989.997882	.96884795E-11	. 99997888E+88 . 99997858E+88
THE TIME	AT THE END O	F MSEMIS IS	82.376 S WERGE				
THE TIME	AT THE END C	F SPORCH IS RECUIRED FOR THI	82.377 S MERGE				
FLXOVA -	LAYER 5 W!	TH 1 PANELS					
LOCATICN	VAVENUMBER	COMP FLUX DN	COMP REFLECT DN	LOCATION	WAVENUMEER	COMP FLUX DN	COMP PERLECT DA
	988.88888	.29247665E-R7	.65334371E-05	924	989.952888	.353658285-87	. 68: <b>85698£Ø</b> 5

THE TIME AT THE START OF SRCFON IS

TABLE B-2 (Cont.)

·64] 哲28255-斯5	.681772565-85 .68168986E-85 .68153428E-85	TOTAL FLUF DA	.355653675- <i>0</i> 7 .36578446E-07	.38297129E-#7 .41874116E-#7 .46312994E-#7
929.962667 .363*B1135-87 .64182625E-B5	.38896834£-07 .68177256E-85 .48873887E-07 .68168986E-85 .45112818E-07 .68153428E-85	LOCATION MAVENUMBER TOTAL FLUX UP TOTAL FLUT DM	989.952888 .293826241-84 .355653571-87 989.967667 .293817831-84 .36578446E-87	969,973333 .2937855555-84 .382971295-87 989,984888 .293723246-84 .4187411665-87 989,994667 .293713965-84 .463129946-87
939.962667	944.973333 944.984666 989.994667	WAVENUMBER	989.952 <i>888</i> 989.967667	969.973333 989.984 <b>8</b> 667 969.994667
gri PO po	99 99 95 85 85 85 85 85 85 85 85 85 85 85 85 85	LOCATION	934 935	936 937 938
19181747E-87 .65334461E-85	.65334510E-05 .65334495E-05 .65334435E-05	TOTAL FLUX DN	.29373278E-87 .29377359E-87	.293487896-87 .29349373E-87 .29369823E-87
.29181747E-87	.291531775-07 .65334510E-05 .29153760E-07 .65334495E-05 .291732112-07 .653344355-05	TOTAL FLUY UP TOTAL FLUX DN	.29940239E-04 .29443278E-87 .29940215E-84 .2937359E-87	.259481885-84 .293481896-87 .299481346-84 .293493736-87 .299480766-84 .293698236-87
988.818667	988,83333 988,832288 988,842667	LOCATION WAVENUMBER	988.808088 988.818687	928.821333 928.832888 988.832888
ra	છ <b>પ્</b> યો	LOCATION	- 14	લ્ડન વ

AVERNIUMER   MSCAT SEC FICK   HS TRANS	THE TIME	AT THE START	T OF SRCFCN IS	82.497				
MAYENUMBER   MSCAT SEC FCM   MS TAAMS   1944   1949   1944   1949   1944   1949   19		LAYER 6	1 PANEL					
980-26667   07-214926E-11   9998882E-88   935   939-95667   999-9567657   999-9567657   999-95975-11   9998882E-88   936   936-95667   999-95975-11   9998882E-88   936   936-95667   999-95976-11   9998882E-88   936   936-95667   999-95976-11   9998882E-88   936   936-95667   999-95976-11   9998882E-88   936-95667   999-971371E-11   9998882E-88   936-95667   939-971371E-11   99988827E-88   936-95667   939-971371E-11   9998882E-88   936-95667   936-95667   939-971371E-11   9998882E-88   936-95667   936-971371E-11   9998882E-88   936-95667   936-971371E-11   9998882E-88   936-971371E-12   939-971371E-12   939-9713	110	-	SCAT SAC FC		LOCATION	NUMBE	CAT SAC FC	MS TRANS
986.22134 5 972.21632 1 9988828E-88 935 997.7333	-	9	244826E	3987988E+#	m	89.95268	8991Ø185E-	.99984118E+##
### 1 FINAL LAYER 15   82.695   12.0998827E-88   938 999.994657   13.09911711E-11   13.0998827E-88   13.0998827E-88   13.099817E-11   13.0998827E-88   13.099817E-88   13.0998	ಚಿ⇔≖	88.81866 88.82133 88.83288	243679E 243463E 243322E	99988#2#E+# 99988#39E+# 99988#4#E+#	(n (n (n	89.95266 89.97333 89.984&B	89918937E-1 89986731E-1 89896958E-1	.99982397 <b>E÷BB</b> .99982194 <b>E÷B</b> B .9998&B71E <b>÷B</b> B
27 MEGLED WITH FILE 28 ONTO FILE 26 VITH XTYPE6739;  28 MEGLED WITH FILE 28 ONTO FILE 26 VITH XTYPE6739;  18 MAVENUMBER MS EMISSION MS TRANS LIGHT PROPERTY CONTRINGER MS EMISSION WAVENUMBER MS EMISSION MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER MS TRANS LIGHT PROPERTY CONTRINGER CONTRIN	vn	80.84266	7243209E-	99988827E+B	ന	89.59466	89911711E-	.99976449E+##
27 MERCED WITH FILE 28 ONTO FILE 26 WITH XTYPE*6739;  N WAVENUMBER HS EMISSION HS TRANS  N WAVENUMBER HS EMISSION HS TRANS  N WAVENUMBER HS EMISSION HS TRANS  DBG #88828 .18255346 .18 9999156 .1834646 .1834646 .1834646 .183	된	AT THE ST	OF MSEMIS I	5.69				
27 HEACED WITH FILE 28 ONTO FILE 26 WITH XTYPE*6739;  N WAVENUMBER HS EMISSION HS :RAMS  WEAVENUMBER HS EMISSION HS :RAMS  988 #884741   18255346E-18   9999815E-88   1485   982 217866   1834464E-18   982 817885   1485   982 217866   1834464E-18   982 817885   1834664E-18   982 817885   18346675   1834664E-18   982 817885   1834612E-18   982 817885   18347885   1834612E-18   982 817885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18347885   18348885   18347885   183488885   183488885   183488885   18348885   18348885   183488885   183488885   183488885   183488885   183488885   183488885   183488885   183488885   183488885   183488885   18348885   183488885   18348885   18	_	AYER 1	AL LAYER 1					
UNIVERSIDED   UNIVERSITY   UN	ш	MERGED	H FILE 28	FILE 26 WITH XTYPE	6739;			
988.88688 .18295346 .184 .999981586 +87	LOCATION	WAVENUMB	S EMISSIO	<u>.~</u>	LOCATION	WAVENUMBER	S EMISSIC	MS TRANS
988.884741 :18295331E-18	0.15	89888 89158 88316	18295351E-1 18295346E-1 1829534ØE-1	99998158E+B 99998151E+B 99998152E+B	444	82 21788 82.21866 82.22824	8344543E-1 8344684E-1 8345122E-1	.99997843E+## .99997781E+## .999977#2E+##
982.229568 .18347318E-18 99996859E+8B 2397 966.811259 .18431793E-18 982.225658 .18347318E-18 99996869E+8B 2399 966.81482811259 .18431793E-18 982.225658 .183477318E-18 99996869E+8B 2399 966.81428 .183477318E-18 99996869E+8B 2399 966.81428 .183477318E-18 996.8259728 .1834768E-18 99998879E+8B 2399 966.81428 .1843173E-18 99998879E+8B 2399 966.81587272 .1855628E-18 986.81373 .18429898E-18 99998879E+8B 2399 967.88737272 .1855628E-18 986.82731 .1842988E-18 99998879E+8B 2399 967.88737272 .1855628E-18 986.82731 .18429888E-18 99998872E+8B 2399 967.88737272 .1855468E-18 986.82731 .18429898E-18 99998872E+8B 2399 967.88737272 .1855468E-18 986.82731 .18429898E-18 99998872E+8B 2399 967.88737272 .1855468E-18 986.82731 .18429898E-18 99998872E+8B 2399 967.8873272 .1855468E-18 986.82731 .18429898E-18 99998872E+8B 2399 967.8873272 .1855468E-18 986.82731 .1842989887E-18 9999887E-8B 2399 967.8873272 .1855468E-18 986.82731 .1842989887E-8B 2399 967.8873272 .1855985E-18 989.88732 .18553858E-18 989.88732 .18553858E-18 989.88732 .18553858E-18 989.88732 .18553858E-18 989.88732 .18553858E-18 989.88732 .18553858E-18 989.88732 .185598748E-18 989.88732 .185598748E-18 989.88732 .18589747E-18 78565 .1	⊸ar vΩ	88.8847 88.8863	8295334E-1 8295327E-1	99998152E+#8	1488	82.22182 82.22348	8345616E-1 8346127E-1	.99997585E+1918 .99997427E+1918
982.22658   18347318E-18   99996859E+88   2399   986.811259   18431793E-18   962.22658   183477818E-18   999956401E+88   2399   966.811259   966.811259   184317818E-18   999956401E+88   2399   966.812648   1843181818118118118118118118181181818181		02.2249	8346839E-1	99997133E+Ø	39	86.88557	1843281BE-1	.999980236+00
926.017580 18347835E-12 9999882E-80 2480 906.816822 1855228E-12 906.017580 18438954E-12 9999882E-80 2395 906.817580 18438954E-12 9999882E-80 2395 909.885432 1855288E-12 906.017580 1842959E-12 9999882E-80 2399 909.885432 1855476E-13 966.02321 1842959E-12 9999883E-80 2399 909.885432 1855466E-13 9999883E-80 2399 909.885432 1855466E-13 9999883E-80 2399 909.885432 1855466E-13 9999883E-80 2399 909.885432 1855466E-13 9999883E-80 2399 909.88582 1855466E-13 9999883E-80 2399 909.89393 1855466E-13 9999883E-80 2399 909.89393 1855466E-13 9999883E-80 2399 909.993481 185585E-13 9999883E-80 2399 909.993481 185585E-13 9999883E-80 2399 909.993481 185585E-13 909.99366-13 18589448E-13 909.81444 185465E-13 9999883E-80 2399 909.993481 18589548E-13 909.993882E-80 2399 909.99348 112 909.99382 18589448E-13 909.81448E-13 909.993882E-80 2399 909.99348 112 909.99382 18589247E-13 909.81448 1 PANCE	เมตา	2.22656 2.22814 2.22972	1834731ØE-1 183477ØØE-1 18347934E-1	99996859E+8 99996481E+8 99995915E+8	000	86.81125 86.81284 86.81442	8431793E-1 84316Ø8E-1 8431413E-1	.99998825E+88 .99998826E+88 .99998827E+88
906.01768	S	2.23130	8347835E-	99995669E+B	2488	86.81688	84311856-1	.93998829E+88
986.822741 .1842968E-1E .99998829E+8B 2399 989.885432 .1855466E-1B 246B 986.822741 .1842968E-1E .99998831E+8B 246B 989.885432 .18553858E-1B 246B 989.885812 .18553858E-1B 246B 989.885812 .18553858E-1B 246B 989.885812 .18553858E-1B 246B 989.885812 .18553858E-1B 246B 989.885812 .18553858E-1B 246B 989.885812 .18553858E-1B 246B 989.8862 .18553858E-1B 989.81753 .18552418E-1G .99998802E+8B 117 989.995862 .18589186E-1B 118 989.995862 .18589186E-1B 118 989.995862 .18589186E-1B 118 989.995862 .18589186E-1B 118 989.995862 .1858918E-1B 118	-2	86.8175 86.8191	1843Ø954E-1 1843Ø5Ø3E-1	99998#28E+#. 99998#29E+#.	ოო	89.88227 89.88385	8556288E-1 8555477E-1	.99998884E+88 .99998884E+88
989.81373 .18552418E-1# .99998##2E+## 989.81373 .1855645E-1# .99998##2E+## 989.81333 .1855644E-1# .99998##2E+## 989.81333 .1855644E-1# .99998##2E+## 989.81333 .1858945E-1# .99998##2E+## 989.81414 .18554257E-1# .99998##2E+## 709.816494 .185496#2E-1# .99998##2E+## 709.816494 .185496#2E-1# .99998##2E+## 70 SECS WERE REQUIRED FOR THIS MERGE 77 SECS WERE REQUIRED FOR THIS MERGE 121 9#9.9998#2 .18589479E-1# 77 SECS WERE REQUIRED FOR THIS MERGE 121 9#9.9998#2 .18589479E-1# 74 THE END OF SRCFON IS #82.874 75 SECS WERE REQUIRED FOR THIS MERGE	ଅବଧ	86.8287 86.8223 86.8239	18438849E-1 18429688E-1 18429299E-1	99998 <i>0</i> 29£+ 99998 <i>0</i> 38£+ 99998 <i>0</i> 31£+	2398 2399 2468	9.8654 9.8678 9.8885	8554668E-1 8553858E-1 8553856E-1	.99999884E+88 .99998884E+88 .99998884E+88
989-814914 .185582575-14 .999988825-48 121 989.998222 .185894595-1999.81649.4 .185496822 .185894595-1999.81649.4 .185496822 .185892475-1	~~æ	89.81175 89.81175 89.81333	18552418E-1 18551667E-1 18558946E-1			9,9,9	8589186E-1 8589362E-1 8589448E-1	.99997926E+88 .99997912E+88
AT THE END OF MSEMIS 1S 82.873 78 SECS WERE REQUIRED FOR THIS MERGE AT THE END OF SRCFCN IS 82.874 77 SECS WERE REQUIRED FOR "HIS MERGE LAYER A WITH I PANELS WAVENUMBER COMP FLUX DN COMP REFLECT DN I OCATION WAVENUMBER COMP FILIX DI	<b>4</b> ™	99.81491	8558257E- 8549682E-	99958BBZE+8	12.0	89.99822 89.99988	8589459E-1	.99957888E+88 .99997858E+83
AT THE END OF SRCFCN IS 82.874 77 SECS WERE REQUIRED FOR "HIS MERGE LAYER A WITH I PANELS WAVENUMBER COMP FLUX DN COMP REFLECT DN	HE TI	AT THE END 8 SECS WERE	MSEMIS IS EQUIRED FOR 7	82,87 S MERGE				
LAYER A WITH I PANELS  WAVERUMBER COMP FILM DN COMP REFLECT DM 10CATION WAVENUMBER COMP FILM DI	HE TIME	AT THE END	SRCFCN 1S EQUIRED FOR ~	82.87 S MERGE				
DAVENUARE COMP FIUX DN COMP REFECT DN TOWN THE TOTAL TO THE TOTAL TO THE TOTAL TO THE TOTAL TOTA		LAYER 4	1 PANEL					
	LOCATION	WAVENUMBER	COMP FLUX DN	COMP REFLECT DN	LOCATION	WAVENUMBER	COMP FLUX DN	COMP REFLECT D

TABLE B-2 (Cont.)

.18515392E-86 .12598354E-84 .18628437E-86 .12597784E-84	.10981413E-86 .12595718E-84 .117808031E-86 .12591612E-84 .12759827E-86 .12585689E-84	WAVERUMBER TOTAL FLUX UP TOTAL FLUX DM	.2939Ø568E-Ø4 .1Ø55242ØE-Ø6 .293913Ø95-Ø4 .1Ø665464E-Ø6	636-84 .118184326-86 826-84 .117378296-86 256-84 .127968856-86
1,05153	.189814] .1178886.	TOTAL F		.293835825-84 .293835825-94
989.936888 989.952888	909.969000 909.984000 916.800000	VAVERUMBER	989.936888 989.952888	929.968888 929.984888 918.60888
<b>622</b> 623	624 625 626	LOCATION	622 623	624 625 625
14883E-84 14891E-84	4877E-04 4828E-04 13949E-8*	FLUX DN	8.06   7.50.7 8.05 7.7 E0.7	88586E-07 91.83E-07 26758E-07
1284	1287	TOTAL	8848	884 884 886
.88119938E-87 .12844883E-84 .88839891E-87 .12844891E-84	.88138889E-B7 .12844877E-B4 .88138889E-B7 .12844828E-B4 .88268889E-B7 .12843949E-B4	TOTAL FLUX UP TOTAL F.UX DN	.2994723ØE-Ø4 .8848Ø617E-Ø7 .29947184E-Ø4 .8848Ø657E-Ø7	
988.88888.8888888888888888888888888888	900.032000 900.048000 900.064000	SCATION VAVENUMBER	988.838888	966.932688 986.848956 986.848956
6	≀ ପୟାଯ	POCATION		1 ल≪।⊓

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V2 < 0 7		.99944725E+## .99943312E+## .99946881E+## .93937£71E+##	.99929896E+88				;	0 E C C C C C C C C C C C C C C C C C C	.999978435+888 493977815+888 .999977825+848	.999974275+88	323E+ <b>8</b>	.99998825E+38 .99998826C+88 .99998827E+88	82+382886665	99998884E+88	.9099811845+28 .999338114E+88 .99398374E+88	. 99997926E+## . 99997911E+## . 99997837E+##	.99997888E+88			COMP REFLECT DI
	,	19254448E-18 19255487E-18 19256124E-18 19255715E-18	.192629316-18					NOTSSING SM	.371568936-13 .37157154E-12 .37158598E-19	.37168053E-12 .37141458E-18	.3740205SE-18	374213585-18 374287645-18 374881565-18	.37359528E-18	.37784598E-18 .37783412E-18	.37787264E-18 .37781155E-18 37780896E-18	.37837795E-18 .379384.2E-18 .37838624E-18	.37828703E+10			COMP FLUX DN
	WAVERUMBER	989,952888 989,962667 989,974333	909.994667					WAVENUMBER	932.217886 982.218667 982.228247	982.223487	986.889679	986.811259 906.812848 986.814428	986.815.888	989.862272 989.8£385?	989.885432 989.887812 885.889593	969,393481 969,395862 583,955642	589.998222 949.99882			VAVENUMBER 909.93680
	LOCATION	ያ መው ው መ መ ው ያ ው ው የ ው	938	•			67391	LOCATION	1484 1485 1486	1487	2396	2397 2398 2399	2488	2396 2397	2398 2399 2488	117	126			LOCATION 622
	MS TRANS	.99956378E+Ø\$ .99956481E+Ø\$ .9996415E+Ø\$			85.177		OFILE 28 WITH KTYPE+	MS TRANS	.9999815468 .99998151E+00 .99998152E+00	9. 0.	. 99997182E+00	.999968595+88 .998964b1E+38 .99995915E+88	5666	99998828E	\$\$\$\$\$\$\$\$\$ \$\$\$\$\$\$3\$E \$\$\$\$\$\$31E	.999984425 .999984625 .999984625 .999984665	9998 <i>88</i> 2 9998 <i>88</i> 2	33.356 15 MERGE	83.357 HIS MERGE	COMP REFLECT DN ,24916381E-84
TH 1 PANELS	MSCAT SRC FON	. 18681385E-18 . 18581229E-18 . 18681176E-18		186611526-10	UF MSEMIS 15	FINAL LAYER 18	H FILE 26 ONT	MS EMISSION	36968676E-13 3696865E-13 3696865E-13	6968578E-7 6968611E-1	371	716409 716502 716503	7165227E -	7398888E-1 7398888E-1 7397863E-1	7396989E-1 7396863E-1 7395157E-1	.377792425-18 .377782926-18	7776655E-1 7775965E-1	OF MSEMIS IS REGUIRED FOR TR	OF SACFON IS REGUIRED FOR T	WITH 1 PANELS OF CCMP FLUY DN 18 .21915#36E-#6
LAYER S WITH	VAVENUMBER	988.818667 988.818667 988.821333	0000750.006	988.842657	AT THE START	4758 1	T MERGED WIT	WAVENUMBER	927.800888 908.80:588	47400.00 47400.00 47400.00	92.22.50	82.21656 82.22814	27.227.20	1758	86.82874 86.82232 86.82338	929.818173 929.811753	69.81491 69.81491 69.81649	AT THE END 79 SECS WERE	E AT THE END 385 SECS WERE	LAVER 3 WAJENUMBE 988.8888
SRCFCN -	NOTTATO	126	•	S	THE TIME	INITIAL	11	CCATION	(1)	າ <del>ຈ</del> າບ	n ~	• ପ୍ର	च ।	o ⊷ c	v m≔túb	-01	უ <b>च</b> ათ	THE TIME	THE TEST	FLXDWN - LOCATION

THE TIME AT THE START OF SRCFCN IS

.268498845-84	.268435845-84 .26838493 <b>E-8</b> 4 .26833478E-84	TOTAL FLUX ON	.375792928-86 .376724:2E-86	.3828697 <i>8£-8</i> 6 .39557248E-86 .41298516E-86
.37595785E-86 .26849884E-84	.3821&363E-Ø6 .26&435&4E-Ø4 .3948%693E-Ø6 .26&72%493E-Ø4 .41222&15E-Ø6 .26Ø1347&E-Ø4	OCATION WAVENUMBER TOTAL FLUX UP TOTAL FLUX ON	909.936000 .29414985E-04 .37579292E-06 909.957000 .29415851E-04 .37672412E-06	999 ( 78 .29414855E-24 989 (8 .29489732E-84 918. 7 .29488637E-84
989.952888	509.968000 909.984 <i>0</i> 00 910.000000	WAVENUMBER	909.936000 909.957000	989 c 8 989 c 8 918.
623	624 625 526 526	LOCATION	622 623	624 625 625
21911550E-86 .24916322E-84	31918874E-Ø6 ,2491621ØE-Ø4 21937357E-Ø6 ,24916ØØ7E-Ø4 31966171E-Ø6 ,249157ØØE-Ø4	TOTAL FLUX DM	.319897 <i>8</i> 5£- <i>8</i> 6 .31986218E- <i>8</i> 6	29967483E-84 .31993541E-86 .29967413E-84 .32812823E-86 .29967323E-84 .3284883 <b>E-</b> 86
.21911550E-86	.319188745-86 .319373576-86 .31966171E-86	TOTAL FLUX UP TOTAL FLUX DM	.29967594E-84 .31989785E-86 .29967541E-84 .31986218E-86	.29967483E-84 .29967413E-84 .29967323E-84
980.816888	988.832888 988.848888 98864888	LOCATION WAVENUMBER	988.85556 988.816888	988.832888 988.848888 988.864880
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87-318-C18597 - 6801107	##+509956#ED.	B270	986.816883	.654873106-10	. 3999888286 • <b>68</b>	
#1+3#5665955   #510161818188 #1+3E8558#551   #52018181848	短輪を回がけるののです。	######################################	909.802272 989.863852	.662632482-18	.959 <b>988842+88</b>	
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34:	AT THE START	OF SRCFCH IS	83.832				
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## TABLE B-2 (Cont.)

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# Appendix C EXAMPLES OF LOWTRAN OUTPUT

Four cases are included as tests for LOWTRAN with multiple scattering. The input cards for the four cases are listed in Table C-1 and the listing of the file OUTPUT (TAPE 6) is in Tables C-2 - C-5. The next section will discuss the output for case 1. Only those details which differ from the standard LOWTRAN output will be discussed.

#### C.1 Case 1: Thermal Scattering of Downward Radiance

This case demonstrates the new multiple scattering calculation for thermal radiance. The parameters selected for this case are as follows: the atmospheric profile is the 1962 U.S. Standard and the boundary layer aerosol model is RURAL with 5 km meteorological range. The path is a slant path from the ground to 20 km with a zenith angle at the ground of 0.0 degrees.

The output for this case shown in Table C-2 will now be described. The first difference is in CARD 1, which now contains another quantity, IMULT. IMULT is the last variable printed on CARD 1, and is the flag for multiple scattering. When IMULT is 1, the multiple scattering features of the program will be used. A message to this effect is printed in the output directly after the message which tells the user that 'PROGRAM WILL COMPUTE RADIANCE'.

The next four pages which print out the 'ATMOSPHERIC PROFILES' and the 'REFRACTED PATH THROUGH THE ATMOSPHERE' are identical to those printed out by LOWTRAN6. The following three pages are not included in LOWTRAN6. These three pages contain the new slant path parameters for using multiple scattering followed by the refracted path used by the multiple scattering run, and the summary of the multiple scattering geometry calculation. The final page is exactly identical except that the radiance that is printed out is the multiple scattered radiance.

### C.2 Case 2: Thermal Scattering of Upward Radiance

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This case is directly analogous to Case I except that the observer is looking straight down instead of straight up. The output differences are the same as those explained for Case I.

#### C.3 Case 3: Solar Scattering of Downward Radiance

Case 3 illustrates the multiple scattered solar radiance calculation. The parameters for this case are the same as those for Case 1, with the addition of the sun at 60 degrees. The output differences are the same as those listed for Case 1, excluding the final radiance output.

The final radiance output has been expanded for the solar case. Two new columns have been added. Under the column heading 'PATH SCATTERED RADIANCE', there are now three columns. These are 'TOTAL' (in both cm-1 and microns) and 'S SCAT' (in cm-1). TOTAL is the total path scattered radiance, containing both single and multiple scattered contributions. S SCAT is the single scattered part of the total path scattered radiance. This S SCAT is the quantity that LOWTRAN would provide under the 'PATH SCATTERED' heading if the user were to run LOWTRAN without multiple scattering. Likewise under the header 'GROUND REFLECTED RADIANCE' there are now three columns. These are TOTAL (in both cm-1 and microns) and 'DIRECT' (in cm-1). TOTAL is the total ground reflected contribution to the radiance, containing both scattered and direct contributions. DIRECT is the direct ground reflected part of the total reflected radiance. The DIRECT term is the quantity that LOWTRAN would provide under the GROUND REFLECTED heading if the user were to run LOWTRAN without multiple scattering. The significance of the S SCAT and the DIRECT terms is that the user can run one case of multiple scattering and by comparing these quantities to the total quantities can determine the relative importance of multiple scattering for that case. This will allow the user to decide more easily whether or not multiple scattering has a significant contribution for that particular case.

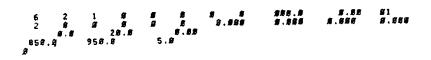
#### C.4 Case 4: Solar Scattering of Upward Radiance

This case is directly analogous to Case 3 except that the observer is looking straight down instead of straight up. The output differences are the same as those explained for Case 3.

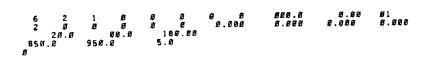
TABLE C-1

INPUT CARDS FOR THE FOUR LOWTRAN TEST CASES

Test Case 1



Test Case 2



Test Case 3



Test Case 4

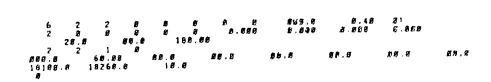


TABLE C-2

LOWTRAN OUTPUT FOR CASE 1

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1300344	BONY'S AUNBOUBLE												
			6.5.2	¥.	-	•	75 MTC	CMCTERC					
	· •		9.25	952 B CM-1		:::	18.53 MICROMETERS)	OMETERS)					

TABLE C-2 (Cont).

Z P T H20 CC2+ D3 N2 (X,M) (MS) (X) (SCALED LOWTRAN GNITS)	P T M20 CO2+ 03 (M5) (M5) (M5)	T W20 CC2+ D3 (SCALE) LOWTRAN GMITS)	T H20 CC2+ D3 (SCALE) LOWTRAN GNITS)	CO2+ DATEN CHITS)	CO2+ ALED LOWTRAN UNITS!	D3 RAN CHITS)	z		CNTMSLF (MOL/CM2 KM)	MOL SCAT	¥ ( )	O3 (UV) ATM CM/KM)
7 (413) 884 (208) 5.758E-81 9.285E-81 2.493E-83 7.	7 (413) 884 (208) 5.758E-81 9.285E-81 2.493E-83 7.	84 (88) 2 5.758E-81 9.285E-81 2.493E-83 7.	88.2 5.7586-81 9.2855-81 2.4936-83 7.	758E-01 9.285E-01 2.493E-03 7.71gE-01 2.387E-03 5.	9.285E-81 2.493E-83 7.7.71E-81 2.387E-43 E.	2.493E-83 7. 2.387E-83 6.		378E-#1	6 m	9.475E-#1 8.6Ø1E-#1	4.6	2.520E-
2.57 795.2848 275.1 2.3238-81 6.4748-81 2.2848-83 4. 5.82 781.284 269.1 1.7428-81 5.3718-81 2.8288-83 5. 4.82 616.672 262.2 7.1668-82 4.4358-81 1.7748-83 3.	795,299, 275,1 2,3236-81 6,4746-81 2,2846-93 4 781,284 269,7 1,7426-01 6,3716-81 2,4286-93 5 616,600 262,7 7,1666-92 4,4356-81 1,7746-83 5	275.1 2.2236-81 6.474E-81 2.284E-93 4 269.1 1.042E-01 6.371E-81 2.428E-83 5 262.2 7.166E-82 4.435E-81 1.774E-83 5	5. 2. 2. 2. 2. 2. 2. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4.	.323E-81 6.474E-81 2.284E-83 4 .382E-81 5.371E-81 2.828E-83 5 .166E-82 4.435E-81 1.774E-83 5	.474E-81 2.284E-83 4 .371E-81 2.828E-83 5 .435E-81 1.774E-83 5	.284E-83 4 .928E-83 5		.878E-81 .927E-81	3.791E+19 1.46ØE+19 5.454E+18	7.788E-Ø1 7.835E-Ø1 6.348E-Ø1	2.238F-84 2.922E-84 1.823E-84	2.520E-83 2.333E-83 2.147E-83
5.6% 548.58% 235.7 3.7456.62 3.6466-01 1.6926-03 2.6 6.8% 472.28% 249.2 1.9926-02 2.9826-01 1.5366-03 1. 7.8% 471.182 242.3 9.8346-03 2.4276-01 1.6326-03 1.	54# 567 2557 3.745E-82 3.646E-81 1.692E-83 2.472.208 244.2 1.992E-82 2.982E-81 1.536E-83 1.411.182 242.3 9.8345-83 2.427E-81 1.632E-83 1.	60 255.7 3.745E-62 3.646E-01 1.692E-83 2.68 249.2 1.992E-82 2.982E-81 1.595E-83 1.88 245.7 9.834E-83 2.427E-81 1.632E-93 1.	5.7 3 245£-62 3.646E-01 1.694E-03 2. 9.2 1.992E-02 2.982E-01 1.536E-03 1. 2.3 9.834E-03 2.427E-01 1.632E-03 1.	.745E-82 3.546E-81 1.592E-83 2. .992E-82 2.982E-81 1.575E-83 1. .834E-83 2.427E-81 1.632E-83 1.	.982E-#1 1.575E-#3 1.427E-#3 1.427E-#1 1.632E-#3 1.	.592E-83 2. .575E-83 1. .632E-83 1.		513E-01 994E-01 572E-01	1.846E+18 6.588E+17 1.988E+17	5.698E-Ø1 5.1Ø8E-Ø1 4.566E-Ø1	1.638E-84 1.469E-84 1.313E-84	2.147E-83 2.182E-83 2.287E-83
8.22 356.50 256.2 5.0045-03 1.9635-01 1.6456-03 1.1 9.00 305.00 229.1 1.5316-03 1.3796-01 2.1306. 10.00 255.20 223.3 5.8946-04 1.2626-01 2.5576-4 7.7	356.500 226.2 5 0046-03 1.9636-01 1.6456-03 289.800 229.7 1.536-03 1.5796-01 2.1306. 265.400 228.3 5.8946-04 1.2666-01 2.5576-4	76 226.2 5 FF48-03 1.963E-01 1.645E-03 80 226.7 1.53E-03 1.579E-01 2.130E.	26.2 5.0042-03 1.963E-01 1.645E-03 29.7 1.53E-03 1.579E-01 2.130E. 23.3 5.894E-04 1.262E-01 2.557E-x	516-03 1.963E-01 1.645E-03 516-03 1.579E-01 2.13ME. .034E-04 1.262E-01 2.557E-1	.963E-#1 1,645E-#3 .379E-#1 2,13#E. .267E-#1 2,557E-x.	.645E-03 .13ØE. .557E-1		232E-91 586E-62 4Ø3E-82	6.498E+16 9.537E+15 1.468E+15	4.869E-81 3.615E-81 3.199E-81	1.178E-54 1.848E-64 9.281E-85	2,427E-83 3,312E-83 4,286E-83
11.87 27.77 216.6 2.8678.91 1.8928-01 3.4938-03 5.11.37 194.871 216.7 9.0758-06 7.6198-02 4.89378-03 4.11.37 165.87 165.87 165.87 165.87 3.9178-75 5.7388-82 4.3588-83 3	227.818 216.6 2.3675-04 1.0025-01 3.4935-03 5 194.818 216 7 9.0755-06 7.6195-32 4.00375-03 4 165.626 216.7 3.9175-75 5.7585-42 4.0236-83 3	216.6 2.367E-04 1.002E-01 3.493E-03 5.193E-03 4 216 7 9.015E-06 7.619E-02 4.0037E-03 4 216.7 3.917E-75 5.73RE-02 4.023E-03 3	16.6 C.367E-04 (.002E-0) 3.493E-03 5.67 9.275E-03 4.037E-03 4.037E-03 4.057E-03 4.053E-03 3.977E-03 4.053E-03 3.977E-05 6.798E-02 4.053E-03 3.977E-05 6.798E-05 6.053E-05 6.055E-05 6.055E-05 6.055E-05 6.055E-05 6.055E-05 6.055E-05 6.055E	.367E-04   .002E-0; 3.493E-03 5. .275E-06 7.619E-32 4.037E-03 4 .917E-75 5.73RE-82 4.028E-83 3	. 502E-01 3.493E-03 5.619E-32 4.037E-03 4.738E-03 3.738E-03 3.738E	.493E-83 5 .837E-83 4 .328E-83 3		.678E-02 .150E-02 .831E-02	3.031E+14 6.17ØE+13 1.460E+13	2.823E-#1 2.413E-#1 2.863E-#1	8.118E-86 6.941E-65 5.932E-85	6.867E-83 7.467E-83 7.933E-83
1.00	7 (4) 720 215.7 1.787E-05 4.357E-92 4.298E-83 1 7 121.174 216.7 1.181E-05 3.340E-92 4.398E-83 1 7 123 544 215.7 5.587E-86 2.537E-97 4.7106-93 1	216.7 1.7375-05 4.3975-02 4.2986-03 1 216.7 1.1816-05 3.3426-02 4.3986-03 1 216.7 5.5876-06 2.5375-06 4.7106-03 1	16.7 1.7878-05 4.3978-07 4.7288-03 16.7 1.1818-05 3.3408-07 4.3886-03 18.7 5.5878-03 18.7	.137E-05 4.3975-#2 4.728E-03 7.181E-75 3.340E-#2 4.398E-83 1.587E-#6 4.7106-#3 1	.3406-02 4.7286-03 1.3406-	. 388E-83 . 7186-83 .		.211E-62 .617E-92 .181E-02	3.1806+12 2.3376+12 1.6776+12	1.763E-F1 1.587E-01 1.288E-01	5.873C+85 4.333E-85 3.703E-85	8.867E-83 9.888E-83 1.128E-72
1.02 88.527 216.7 6.4328-06 1.9728-82 5.1618-83 8 19.82 75.538 216.7 4.7268-26 1.4688-22 5.5488-83 6 19.82 64.676 216.7 4.1048-86 1.1148-82 5.6918-83 4	88.527 216.7 6.4326-06 1.4736-82 5.1615-83 75.538 216.7 4.7266-26 1.4666-22 5.5486-03 64.674 216.7 4.1045-06 1.1146-02 5.6916-03	27 216.7 6 4326-06 1.9286-02 5.1616-03 54 216.7 4.7266-26 1.4666-22 5.5406-03 74 216.7 4.1048-06 1.1146-02 5.6918-03	16.7 6.4326-06 1.4296-82 5.1615-03 16.7 4.7266-26 1.4666-22 5.5406-03 16.7 4.1046-06 1.1146-02 5.6916-03	.4326-069296-82 5.1615-83 .7266-26 1 4666-22 5.5406-83 .1045-86 1.1146-82 5.6915-83	.9256-82 5.1618-83 4668-82 5.5488-83 .1148-82 5.6918-83	.1612-03 .5402-03 .6912-03		.6376-83 .311E-83	3.219E+12 B.726E+11 B.726E+11	1.101E-01 9.411E-02 8.845E-02	3.166E-05 2.707E-35 2.314E-85	1.3075-82 1.4935-92 1.6335-92
2P.2F 5.290 216.7 3.564E-05 8.470E-03 5.803E-03 3 21.27 47.290 217.6 3.371E-06 6.486E-03 5.447E-03 2 22.82 43.47E-03 5.248E-03 1	55.290 216.7 3.564E-05 8.478E-03 5.803E-03 47.290 217.5 3.371E-06 6.486E-03 5.447E-03 47.470 218.5 3.168E-06 4.847E-03 5.248E-03	90 216.7 3.364E-05 8.470E-03 5.803E-03 90 217.5 3.371E-06 6.486E-03 5.447E-03 70 218.5 3.168E-06 4.847E-03 5.248E-03	6.7 3.564E-05 8.470E-03 5.803E-03 17.5 3.371E-06 6.406E-03 5.447E-03 18.5 3.168E-03 6.487E-03 5.248E-03	.564E-05 8.470E-03 5.803E-03 .371E-06 6.406E-03 5.447E-03 .168E-06 4.847E-03 5.248E-03	.4786E-83 5.8836-83 .486E-83 5.4476-83 .847E-83 5.248E-83	5.803E-03 5.447E-03 5.248E-03		.371E-03 .451E-03 .783E-03	8.726E+11 1.038E+12 1.219E+12	6.878E-82 5.859E-82 4.991E-82	1.979E-05 1.685E-25 1.435E-85	1.773E-82 1.773E-82 1.628E-82
23.88 34.672 219.6 3.015E-06 3.675E-03 4.8072E-03 1 24.88 29.728 220.6 2.803E-06 2.789E-03 4.274E-93 9 25.00 25.490 221.6 2.636E-06 2.119E-03 3.792E-03 5	24.672 219.6 3.015E-06 3.675E-03 4.8072E-03 29.720 220.6 2.803E-06 2.789E-03 4.274E-93 25.490 221.6 2.63E-06 2.119E-03 3.792E-03	72 219.6 3.015E-06 3.675E-03 4.8072E-03 20 210.6 2.803E-06 2.789E-33 4.274E-93 90 21.6 2.63E-06 2.119E-03 3.792E-03	19.6 3.015E-06 3.675E-03 4.8072E-03 20.6 2.803E-06 2.789E-33 4.274E-93 21.6 2.636E-06 2.119E-03 3.792E-03	.015E-06 3.675E-03 4.802E-03 .803E-06 2.789E-33 4.274E-93 .636E-06 2.119E-03 3.792E-03	.675E-03 4.802E-03 .789E-03 4.274E-93 .119E-03 3.792E-03	.802E-03 .274E-93 .792E-03		.299E-83 .483E-84	1.464E+12 1.677E+12 1.963E+12	4.256E-#2 3.632E-#2 3.101E-#2	1.224E-Ø5 1.844E-Ø5 8.918E-Ø6	1 7735-82 1.6865-82 1.5875-82
32.88 11.970 226.5 7.6126-07 5.476E-04 1.642E-03 1 36.89 5.746 236.5 1.624E-07 1.429E-04 6.674E-04 3 42.80 2.871 258.4 3.549E-08 3.922E-85 2.227E-04 7	11.97# 2.6.5 7.612E-#7 5.47E-#4 1.642E-#3 1 5.746 236.5 1.624E-#7 1.429E-#4 6.674E-#4 3 2.871 25#.4 3.549E-#8 3.922E-#5 2.227E-#4 7	76 226.5 7.612E-07 5.476E-04 1.642E-03 1 46 236.5 1.624E-07 1.429E-04 6.674E-04 3 71 250.4 3.549E-08 3.922E-05 2.227E-04 7	16.5 7.612E-07 5.476E-04 1.642E-03 1 36.5 1.624E-07 1.429E-04 6.674E-04 3 50.4 3.549E-08 3.922E-05 2.227E-04 7	.612E-07 5.476E-04 1.642E-03 1.624E-07 1.429E-04 5.674E-04 3.549E-08 3.922E-05 2.227E-04 7	.476E-04 1.642E-03 1 .429E-04 6.674E-04 3 .922E-05 2.227E-04 7	.642E-#3 1 .674E-#4 3		.4796-84 .1935-85 .3186-86	6.508E+11 1.154E+11 2.023E+18	1.425E-02 6.550E-03 3.891E-03	4.897E-86 1.884E-96 8.889E-87	9.333E-03 5.133E-03 2.287E-03
45.08 1.491 264.2 9.176E-09 1.157E-05 5.881E-05 1 50.00 .799 270.7 1.939E-09 3.747E-06 1.072E-05 5 70.00 .855 219.7 2.406E-12 4.660E-08 8.259E-08 3	1.491 264.2 9.176E-Ø9 1.157E-Ø5 5.881E-Ø5 1.798 278.7 1.939E-Ø9 3.747E-Ø6 1.072E-Ø5 5.881E-Ø8 3.747E-Ø6 1.072E-Ø8 3.259E-Ø8 3.259E	264.2 9.176E-89 1.157E-85 5.881E-85 1 3 278.7 1.938E-89 3.747E-86 1.872E-85 5 5 219.7 2.486E-12 4.668E-88 8.259E-88 3	64.2 9.176E-#9 1.157E-#5 5.881E-#5 1.76.7 1.939E-#9 3.747E-#6 1.#72E-#5 5.81E-#8 1.#72E-#8 1.#72	176E-09 1,157E-05 5,001E-05 1,038E-05 1,038E-09 3,747E-06 1,072E-08 8 1,406E-12 4,560E-08 0,259E-08 9	.157E-#5 5.881E-#5 1 .747E-#6 1.#72E-#5 5 .668E-#8 8.259E-#8	5.881E.85 1 1.872E-85 5 8.259E-88 3		.821E-86 .877E-87 1.291E-89	4.615E+89 6.498E+89 1.0145+85	1.521E-83 7.945E-84 6.773E-85	4.375E-87 2.285E-77 1.948E-88	7.933E-84 1.867E-84 4.813E-86
188.88 . 888 218.8 1.582E-16 5.428E-12 5.188E-12 1	. 200 218.8 1.502E-16 5.428E-12 5.188E	218.8 1.582E-16 5.428E-12 5.188E	18.8 1.502E-16 5.428E-12 5.188E	5.82E-16 5.428E-12 5.188E	.428E-12 5.188E	. 188E		. B46E-13	4.5875+88	3.861E-87	1.1115-19	2.8678-89

TABLE C-2 (Cont).

RM (PERCAT)	4.589£+#1	5.201E+81	. ABBE+88	. NRBE + 88	. 888E +88	. BBBE + BB . BBBE + BB	. BBBE+BB . BBBE+BB	. 008E+28 . 000E+88	. 888E • 88	739E + 88 738E + 88 888E + 88 738E 7	000E+B8	. 888E+88	0005-60 0005-80 0005-80	. 0005-488 . 0265-488 . 0005-88	
CIRRUS	. BAGE + BB . BASE + BB	. BREC+88	. 836E+88 . 886E+83	. 885E+89.	. 800E+88	. 000E+00	BBSE+BB	. 888E+88	. 008E+80	602E 608E 608E 608E 608E 608E	. 888E+83	. 888E+88	. 8885 + 88 . 8885 + 83 . 886 E + 62	. 8885+88 . 8885+88 . 8885+88	
ASRI *RH	3.533£+Ø1	3.23AE+88 . BBBE+88	. BBBE+BB . BBBE+BB	. BBOE+BB	. BBBE + BB	. 000 E + 00	. 888E+88	. 888E+88	. BR BE + BB	. 2005 + 34 . 2005 + 36 . 2005 + 38 . 2005 + 38 . 3005 + 300	. 888E +88	. 888E+38	. BB BE + BB . UB BE + BE . DOBE + AB	. 888E+88 . 878E+88 . 837E+73	
AEROSOL 4 {-}	. 868E+88	. 8585 + 85 . 8585 + 68	. 868E + 88	. 888E + 98 . 888E + 98	. 888E +88	. BBBE+87 . BBBE+88	. 888E + 98 . 888E + 88	. 8885+88 . 8885+88	. 000E + 00	. 000E+00 . 000E+00 . 000E+00 . 000E+03	. 888E+88	. BBBE+BB.	1.640E-85 7.990E-86 4.010E-06	2.100E-06 1.600E-0 9.310E-10	
AEROSOL 3	. BBBE+RB . BBBE+83	. 700E + 80	. 888E +88	. DBBE+BB	. abbe + bb . abbe + bb	1.148E-83 7.998E-84	6.418E-84 5.178E-84	4.428E-84 3.950E-84	3.828E-84	5.10000-04 5.1000-04 5.9000-04 5.7296-04 4.2000-04	3. PRBE-B4 1.98UE-B4	1.318E-04 3.328E-05	. 2005 + 38 . 1006 + 38 . 1008 E + 88	.8885+83 .4085+88 .0085+00	
AERGSOL 2 (-)	. 8897+38 . 8385+88	. BORE + 07	1.856E-82 9.314E-03	7.710E-03 6.2305-03	3.370E .03 1.826E-07	. BUSTE+ON . BONE+OU	. 883E+38 . 888E+88	. 8035E+80	. 8255. . 8836-88	. 888E+38 . 888E+38 . 888E+88 . 888E+88 . 888E+88	. 888E+88	. 8885+08 . 8845+88	. UPBE+8B . BOUE+3B . BOUE+0B	. 880E.+88 . 880E.+86 . 888E+68	
AEROSOL 1	7.788E-81	6.2186-02 . 200e-50	. DROE + CB . BONE + OF	. សម្រាស់ - ស្រុស ភូមិស្រុក - ស្រុស	. 888E+88 . 838E+83	. 888E+88	. 889E + 88	. BORE + BB . BORE + BB	. ଅନ୍ତହ + ୨୨୫ . ଜନ୍ୟ = + ୬୫	\$\$\$\$\$\$. \$	. 800E + 88	. 000E+00	. 000E+00 . 000E+00 . 000E+00	. 000E + 30 . 000E + 00 . 000E + 00	
NNO3 ATH CM/KW	.8885+29 9885+28	. 8985+69.	. ชช.ชธ.+20 . ชมละ: +00	ម្រុក្សដូច្នេះ ម្រុក្សដូច្នេះ .	1.869E-35	1.856E-85 2.258E-85	2.896E-85 2.888E-05	2.820E-05 2.712E-05	2.446E-85 2.282E-85	1.975E-855 2.955E-85 2.953E-85 2.158E-05 2.95E-05	2.213E-05 2.179E-25	1,178E-05 3,784E-06	1,441E-07 3,091E-37 .080E+0A	. 888E+04 . 886E+04 . 886E+04	
CNTMFRN MOLICM2 KM	2.0108+22	8-1436+21 4-5736+21	2.521E+21 1.019E+21	7.825E+28 3.472E+28	1.768E+20 6.023E+19	2.086E+19 8.384E+16	3.235E+18 1.345E+18	5.364E+17 3.929E+17	2.845E+17 2.874E+17	1.5826+17 1.2826+17 1.8966+17 1.3196+17 9.4816+16	8.788E+16 8.825E+16	7.414E+16 1.961E+18	3.796E+15 7.502E+14 1.764E+14	3.4547+13 3.6846+17 1.3996+176	
r E	268.2 281.7	275.2	262.2	249.2	236.2	2:3.3	2:6.7	216.7	216.7	8 45 A 44	219.6	271.6	236.5 256.4 264.3	1 1 G	ANGLE
4 N	18:3 872 896.888	795.888 781.288	616.600 542.500	997 : : : 5 987 : : : 5	326, <b>50</b> 0	265.888 257.888	194.868 165.808	141.782	173.5£ 88.580	7. 6.0 6.4 7. 6.0 7. 6.	34,614	35.190 31.97	5.746	795 855 955	X H1. H2.
A S	59.1	دار و. و. و. وه	4 10 61 27 67 68	60 CH	93.6 58.8	18.88 11.88	32.88 13.88	14.82	16.00 17.80	20.25.05 20.25.05 20.25.05 20.25.05 20.25	23.88 24.88	25.82 38.88	35.68 44.80 45.80	50.95 30.95 18.861	2A: G1VE
		(n <b>4</b>	क्षा बढ़	lω	0 · Cv	=:4	() <del>4</del>	in w	fs 00	のだっこと ではってい	1.5 4.8	91.	5440 5440	(1 (n m	CASE ?

SLANT PATH PARAMETERS IN STANDARD FORM

ATMOSPHERIC PROFILES

TABLE C-2 (Cont).

TABLE C-2 (Cont).

RHOBAR	(GM CM-3)		9 1.17E-83	9 1.86E-83 9 9.57E-84 9 8.63E-84 9 7.77E-84	6 6 98E - 84 6 5 5 4E - 84 8 5 5 7E - 84 8 6 5 6 E - 84	5 4.48E-84 3 3.89E-84 5 3.38E-84	0 2.39E-84 6 2.47E-84 6 2.11E-84	48-11-0-10-0-10-0-10-0-10-0-10-0-10-0-10		CNTMFRN MOL CM-2) 1.629E+22	.668E+2.	.817E+22 .9155+22 .965E+22	.99#E+22 .8#1E+22 .##5E+22	.0860+22 .0878+22 .8370+22	. 8 8 1 8 4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
TBAR	ŝ		284.9	278.2 271.9 265.8 258.9	252.5 246.8 239.5 233.8	226.5 228.1 216.7	216.7 216.7 216.7 216.7	00000 0000	;	2.5 2.5 3.6 4.7	0.0.c. 1	E+13	E+19 0 44	4 + 19	0 t + 3
PBAR	(MB)		955.683	846.698 717.913 658.727 518.391	516.204 441.516 383.677 332.137	216.399 215.987 218.499	153.758 153.758 151.486	96.00 81.00 70.10 70.10 90 90 90 90 90 90 90 90 90 90 90 90 90		CNTMSL (MOL CM-	842 638	8.9636 9.0770 9.1158	9.127 9.138 9.138	91316	9.131
BENDING	(DEG)		. 966	888. 888.	888. 888. 884.	885. 885.	388. 388. 388.	385 385 385 385		CNTMSLF! MOL CM-2) 1,138E+20	. 944E+2 . 837E+2	2.871E+20 2.881E+20 2.885E+20	2.887E+28 2.887E+28 2.887E+28	2.087E+20 2.087E+20 2.087E+20	2.887E+20
DBEND	(DEC)		. 888	888. 688. 989.	888 888 888 888	ନ୍ଧ୍ର ବ୍ୟୁ ବ୍ୟୁ	838. 838. 838.	କ୍ଷୟ : ଅଧିକ ଓ ଆଧିକ :		03 UV M CM) (	#E-#3 5E-#3 4E-#3	56 - 16 - 16 - 16 - 16 - 16 - 16 - 16 - 1	16 - 81 9E - 82 5E - 82	86 E + 80 50 E + 80 50 E + 60 50 E +	56-102 8E-102
РНТ	(DEG)		188.808	188 208 188 838 184 868 187 668	136.000 186.000 180.000 180.000	888 881 883 98 887 351	180.000 180.028 180.028	186,808 189,000 180,008		3 (AT)	1 10 to 10 t	1.18 17 1.39	5 1.85 6 2.13 6 2.51	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	5.31
BETA	(DEG)		883.	988 988 988 988	368. 368.	338. 338. 336.	999 999 3199 3199	868 868 868 868 868		HNO (ATM CM (ATM CM	* * * * W W W	. 780E+8 . 780E+0 . 388E+8	2.034E-3 1.807E-0 8.893E-0	2.546E-# 5.:23E-@ 8.715E-0	1.887E-8
DRETA	(DEG)		ere.	288 288 288 288	983. 388. 388.	ମନ୍ତ ମନ୍ତ ମନ୍ତ	988. 988.	388. 389. 389.	10 2	03 TS) 448F-63	.775E-0 .924E-0	.218E-02 .318E-02 .379E-02	. 543E - 82 - 732E - 82 - 966E - 83	. 2686-07 . 645E-02 . 048E-02	.461E-02
RANGE	)		1.888	(10.47) ##### #####	99. 6 9. 6 9. 6 9. 6 9. 6	18.826 11.886 12.986	13.525 14.886 15.888	17.888 18.888 19.888 28.888	16. 22	CO2+ WTRAN UNI	16 + 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	35 + 44 4 1 35 + 44 4 1 1 35 + 44 4 1 1 1	15+80 1 85+80 1	27 + 98 BE+88 2 - 88 3 - 88 3 - 88	7E+80 3
SHANGE	(KH)		1.888	888 888 888 888 888 888 888 888 888 88	8 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	8666 8866 8666	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	THE PAT	CALED LO		6.00 6.00 6.00 6.00 6.00	2.85 2.4.83 3.4.17	67. 4 9 67. 4 9 67. 4 9	P 4.49
TMETA	(050)		489.	999 999 999 999	8888 888 888 888	0000 000 000	888 888 888 888	23.8 23.8 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0	DENTS SO	27H	3.00 mm. 3.00 mm. 3.00 mm. 3.00 mm. 3.00 mm. 3.00 mm. 3.00 mm.	1,8985+80 1,1185+80	1.1398+38+1.1	1.148E+20 1.1485+20 1.1485+20	1.144E+21
	0 E	0 H D	1. 527	2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2	888 888 97 88		5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	6 6 6 6 6 6 7 6 7 6 7 8	er Lu	a -	404 0 - 5	ם ווייב	6 6 4 6 6 4	555 11.1. 531 11.1.1	216.32
ALT	FROM FUNDA FUNDA	ัส ส	999.	# C. C. A.	8800 8800 8000 8000 8000 8000 8000 800	888. C. C. C. C. C. C. C. C. C. C. C. C. C.	to by to by	Section Sectio	<b>4</b> 	(N )			8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	997.E:	14.230 15.688
				(u m et ib	ար աս	ن ن د ن	m an ru ru	e u, u tu ⊶ ⊶ ⊷ tu	CUML	n -	- 11m <del>-</del>	LO O T	0 0 E	125	

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

TABLE C-2 (Cont).

4.8875+22	4.007E+22 4.007E+22 4.007E+22	4.087E+22													
9.1315+19	9.131E+19 9.131E+19 9.131E+19	9.1315+19	v	č,	<b>ಇ</b> ಆರಾಭ	ភ្នុងស្ព	ଷ୍ଟ୍ରଷ୍ଟ	୍ଦ ଦ ଦ ଦ	පසුස					CMOL CM-2	4.987E+22
2.887£+2#	2.887E+25 2.887E+29 2.887E+29	2.8878+27	01/80	. RABL + BR	008:+80 008:+80 008:+80	. 000E+91 . 400E+81 . 600E+81	. 8685.48 . 8385.48 . 8385.48	. 000E+D. . 000E+B. . 000E+B.	. 000E+B . 000E+B . 000E+0					CNTMSLF2	9.1316+19
. 298E-B2	.5126-82 .9126-82 .1486-01	.318E-81	AER 4	00 + J. rov.	. 898E + 88 . 888E + 88 . 888E + 88 . 888E + 88	. 888E+88 . 888E+88 . 888E+88	. 888E+88 . 888E+88 . 888E+88 . 888E+88	88+3889 889:488 889:488	. 2086 + 38 . 4866 + 48 . 488 E + 48					CNTMSEF1	2.8876+20
621E-84 7	.853E-04 8 .062E-04 9	.449E-04 1	AER 3	. OUPE + DB	\$64569 \$64569 \$64569 \$64569 \$64569	. 488E + 48 . 188E + 48 . 188E + 48	5.788E-04 1.529E-03 2.247E-03 2.013E-03	3,3026-83 3,3206-03 4,1086-03 4,5126-03	4,984E-03 5,535E-03 6,120E-03					O3 UV (ATM CM) (	1.3185-01
347E-82 1.	840E-02 1. 375E-02 2. 937E-02	5126-02 2	AER 2	. 030E+38	. \$405 + FB 1.7301 - 62 4.382E - 62 5.648E - 82	6.488E-82 7.183E-82 7.648E-82 7.988E-82	7.991E-82 7.991E-82 7.991E-82 7.991E-82	7.991E-82 7.991E-82 7.991E-82 7.991E-82	7.991E-02 7.991E-02 7.991E-02					HNO3	.449E-84
565£+## 4.	5878+00 4. 6238+00 5. 6168+86 5.	626E+RB 6.	AFR 1	10-300:14	1.0951E+98 1.092E+98 1.082E+88	1.882E+88 1.882E+88 1.882E+98 1.882E+98	1.882E+88 1.882E+88 1.882E+88	1.082E+08 1.082E+08 1.982E+00	1.882E+88 1.882E+88 1.882E+88				AMOUNTS	ONITS) (	512E-#2 2
.1452+98 4.	.1445+88 4. .1445+88 4.	.1446.00 4.	אָטר צניז.	9.0315-01	1,7205+88 2,4626+80 3,1316+80 3,7326+88	4.272E+88 4.755E+88 5.186E+88 5.578E+88	5.918E+88 6.211E+88 6.472E+88 6.695E+88	6.885E+00 7.049E+00 7.189E+00 7.308E+00	7.418E+BB 7.497E+BB 7.571E+BB	CALCULATION	MX 595.32	8.340 DEG 8.340 NN 8.30 B DEG 9.30 B DEG 8.30 B DEG 8.30 DEG	. ABSORBER	CO2+	4.626E+## 6
216.78 1	92.917. 97.917. 16.76	216.70	FROD CA	6.6715-81	1.0895.68 1.0476.48 2.4886.88	2,583E+88 2,83E+88 2,873E+88 2,932E+88	3.016E+00 3.031E+000 3.130E+00	3.1915.00 3.2155.00 3.2155.00 3.2356.00 3.2356.00	3.242E+88 3.248E+88 3.252E+88	HE GEOMETRY (			EA LEVEL TOTAL	H20 (SCALED	1.144E+80
16.888	17.682 18.683	23.82	អន្តិ	1.000	5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5	8.889.8 9.889.8 9.8899.6	18.888 11.888 12.888 13.888	14.988 15.288 16.828	18.888 19.888 28.888	ARV OF T	I I	L B H T B B B B B B B B B B B B B B B B B	OUIVALENT SE		J.,
1.	. set.	ë	٠,	-	ព្យៈមហ	wor∿ eo or-	# → 12 E	4 W & L	18 19 27	SUMP			EOU		

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TABLE C-2 (Cont).

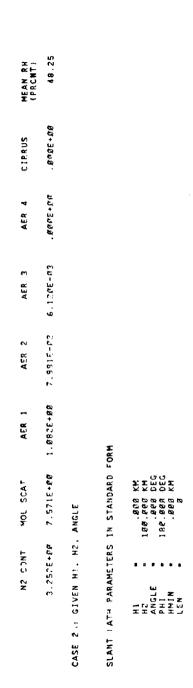


TABLE C-2 (Cont).

GM CM-3) 216.78 217.14 218.69 219.89 4 0 5 8 6 8 8 219.499 179.988 153.758 131.488 112.300 95.000 82.075 78.160 CNTMSLF1 O3 UV (ATH CH) 2.528E-83 5.848E-83 7.465E-83 HN03 . 888E +88 . 885'E +88 . 888E +88 2.448E-83 4.775E-83 6.924E-83 CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE H20 CO2+ (SCALED LOWTRAN UNITS) Ξ RANGE CUMULATIVE ABSOPBER AMOUNTS FOR THE PATH FROM 8.505E-01 1.561E+03 2.151E+030 DRANGE 4.664E-81 7.631E-81 9.394E-81 (DEG) A. TITUDE FROM TO (KM) (LM) 

2.086E+20 9.115E+19 3.965E+22 2.086E+20 9.115E+19 3.965E+22 2.087E+20 9.127E+19 4.001E+22	E+2 <i>B</i> 9.131E+19 4.805E+22 E+2 <i>B</i> 9.131E+19 4.806E+22 E+2 <i>B</i> 9.131E+19 4.807E+22	9.131E+19 4.087E+22 9.131E+19 4.087E+22 9.131E+19 4.087E+22	+19 4.887E+22 +19 4.887E+22 +19 4.887E+22	4.807E+22 4.807E+22 4.807E+22	007E+22 007E+22 007E+22	+++ +22 +++	-2 (C	•22 •22						
2.086E+20 9.115E+19 3.95E+2 2.087E+20 9.115E+19 3.96E+2 2.087E+20 9.127E+19 3.99E+2	+2¢ 9.131E+19 4.895E+2 +2¢ 9.131E+19 4.806E+2 +2¢ 9.131E+19 4.897E+2	.131E+19 4.087E+2 .131E+19 4.087E+2	+19 4.807E+2 +19 4.807E+2 +19 4.807E+2	.887E+2 .887E+2	97E+2 97E+2 97E+2	4 4 4	200	22						
2.086E+20 9.115E+1 2.087E+20 9.115E+1 2.087E+20 9.127E+1	+28 9.131E+1 +28 9.131E+1 +28 9.131E+1	.131E+1 .131E+1	+ + +		4 4 4	4.087 4.087	4.0876 4.9078 4.0878	4.807E						
2.085E+2 2.085E+2 2.087E+2 2.087E+2	4 + +		9.131E 9.131E 9.131E	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19	v	සු කු සු	55 55 55 55	<b>0000</b>	ଷ୍ଠବ୍ୟ	c
	2.08? 2.08? 2.087	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28	CIRRU	. 999E + 8 . 996E + 8 . 996E + 9	. 888E + . 858E + . 888E +	. 2006 - 40 . 2006 - 40 . 2006 - 40 . 2006 - 40	8+3888. 8+3889. 8+3889.	0.7000
. 617E-82 . 852E-82 . 139E-82	. 515E-82 . 828E-82 . 785E-82	.475E-82 315E-82 .248E-82	.298E-82 .512E-82	.148E-01 .318E-01 .495E-01	.675E-01 .854E-81	. 196E-81 . 866E-81 . 157E-81	.333E-81 .484E-81 .425E-81	. 434E-01	AER 4	. 999E+99 . 9696+99 . 899E+99 . 699E+99	. 868E + 88 . 866E + 88 . Free + 98 . 888E + 88	. 808E + 98 . 868E + 58 . 886E + 38 . 886E + 38	. 866E+88 . 866E+86 . 888E+88	40.1000
.8875-156 2	.893E-06 2 .546E-05 3	.015E-85 4 .087E-04 5 .363E-94 6	.6218-04 7 .8530-04 8 .0628-04 9	.2532-84 .4495-64 .6615-84	.874E-84 1 .889E-84 1	.472E-74 2 .821E-64 2	.876E-04 3	.876E-04 3	AER 3	. 1789E+88 . 1789E+88 . 1789E+88	. 868E+88 . 888E+88 . 888E+88	.000E+88 5.70E-84 1.529E-83 2.247E-83	2.828-83 3.3828-83 3.7288-83 4.1888-83	6 6176-01
.379E-8 .543E-8	.966E-B2 .268E-82 .645E-02	.0485-02 8 .4616-02 1 .8925-02 1	.347E-02 1 .848E-02 1 .375E-02 2	.937E-82 2 .512E-82 2	.689E-02 2 .111E-22 3	.967E-02 3 .025E-01 3	.0998-01 3 .1868-01 3	.107E-01 3	AER 2	. \$885 - 488 . \$885 - 488 1.7385 - 82	5.648E-82 6.488E-82 7.183F-82 7.648E-82	7.991E-82 7.991E-82 7.991E-82 7.991E-62	7.991E-02 7.991E-02 7.991E-02 7.991E-02	7 9915-03
.643E+88 .861E+88	. 1798+88 . 2946+88 . 3886+88	.446E+88 .497E+88 .535E+88	.555E+08 4 .587E+08 4 .584E+08 5	.616E+00 .676E+00	.639E+00 7 .643E+00 8 .647E+00 8				AER 1	7.788E-81 1.851E+88 1.882E+89 1.982E+89	1.082E+80 1.982E+80 1.882E+80 1.982E+80	1.882E+88 1.882E+88 1.882E+88	1.882E+88 1.882E+88 1.832E+88 1.882E+88	1.8825+88
132E+03 159E+7	.144E+86 .144E+88	.144E+88 .144E+88	.144E+88 .144E+88	. 1445+80 . 1445+90 . 1445+30	. 144E+80 . 144E+80	. 1445+00 . 1445+00 . 1445+00	. 1445+80 . 1445+00	. 1445+00 4 . 1445+00	MOL SCAT	9.831C-81 1.722E+88 2.462E+98 3.131E+88	.732E+8 .272E+8 .755E+8	.918E+8	6.695E+88 6.886E+88 7.849E+88 7.189E+88	7. SMRE+89
3.5.5.69 3.5.69 3.5.69 3.5.69 3.5.69	26.55 20.18	216.78 1 216.78 1 216.78 1	215.70 1 216.70 1 215.70 1	216.7£ 1 216.7£ 1 217.14		6 000 6 000 6 000	ក្រុក មានក្រុ	000 000 000 000 000 000 000 000 000 00	NO CONT	6.6715-81 1.2895+68 1.5475+88	2.587E+88 2.586E+88 2.583C+88	.932E+ .016E+ .831E+	+ + + 36 - + + + 36 - + + + 36 - + + + 36 - + + + 36 - + + + + 36 - + + + + 36 - + + + + + + + + + + + + + + + + + + +	30+152. 8
0000	10.000 11.000 12.200	13.888 14.888 15.888	16.000 17.000 18.000	19.228 28.888 21.888	27.888 23.888 24.888	35.666 38.866 35.558	48.698 45.699 58.899	000 00 000 00	M ( )	1.638 2.638 3.686 4.686	5.686 6.686 7.686 8.688	9.002 18.000 11.000	13.658 14.566 15.666 16.689	17 909
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	7.800 245.80 1.132E+80 3.643E+80 1.379E-82 .8088E+8 8.800 229.50 1.159E+7 3.861E-80 1.543E-8 2.834E-8 9.000 233.80 1.142E+80 4.838E+90 1.732E-82 1.887E-5	7 7.809 245.87 1.132E-72 3.643E+88 1.379E-82 2.034E-39 8.692E-89 1.379E-82 2.034E-39 9.047 2.33.07 1.132E-72 4.038E+98 1.732E-82 1.887E-3 8.993E-81 1.3008 2.045E-82 4.179E-72 4.179E-72 8.893E-82 1.144E-82 4.179E-72 4.179E-72 2.045E-82 2.246E-82 2.123E-82 2.123E-83 2	7 7 800 216.76 1.132E-87 3.643E-90 1.379E-82 .888E-89 9.048 2.9.56 1.135E-87 3.643E-90 1.532E-82 2.034E-89 9.048 2.9.56 1.145E-80 4.033E-90 1.532E-82 1.887E-90 1.545E-82 2.034E-82 2.034E	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	7 7 7 7 7 8 9 8 2 4 5 9 8 1 1 3 2 E 7 7 7 7 7 8 9 8 2 4 5 9 8 1 3 2 E 7 8 1 2 E 7 8 1 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	7 7 8 8 8 1 3 7 5 6 8 8 1 1 3 7 5 6 8 8 1 3 7 5 6 8 8 8 9 7 8 8 9 8 1 3 7 5 6 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 9 7 8 8 8 9 7 8 8 8 9 7 8 8 9 8 9	7 7 7 7 7 8 9 8 2 4 5 9 8 1 132 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 6 1 2 E + 7 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	7. 22 6 6 6 6 70 1.144	7 7.898 245.88 11326.72 3.6416.88 11356.82 1.8895.72 3.8895.89 1.3756.89 1.3	1, 20	12   200	12   12   12   12   13   14   15   15   15   15   15   15   15	12   12   12   13   14   15   15   15   15   15   15   15

			CNTMFRN (MOL CM-2)	MEAN PH (PRCNT)
. 689E+88 . 689E+98 . 689E+98 . 689E+89 . 689E+89	. 008E+80 . 008E+80 . 008E+80 . 008E+80 . 000E+80 . 000E+80		CNTMSLF2 (MOL CM-2) 9.131E+19	CIRRUS .ørbE÷8\$
. 6685 + 685 . 8685 + 683 . 8665 + 66 . 8665 + 66 . 9665 + 68	. 000E+00 . 000E+00 4. 100E+00 9. 948E-05 9. 948E-05 1. 283E-04 1. 591E-04		CNTMSLF1 (MOL CM-2) 2.887E+28	AER 4 1.591E-84
4.984E-83 5.535E-83 6.128E-83 7.124E-93 7.481E-83	7.898E-03 8.245E-03 8.328E-03 8.328E-03 8.328E-03 8.328E-03 8.328E-03		03 UV (ATM CM) 3.434E-01	AER 3 8.328E-Ø3
7.991E-82 7.991E-82 7.991E-82 7.991E-82 7.991E-82	7.991E-82 7.991E-82 7.991E-82 7.991E-82 7.991E-82 7.991E-82		HNC3 (ATM CM) 3.876E-£A	AER 2 7.991E-#2
1.892E+88 1.892E+88 1.892E+88 1.092E+98 1.992E+98 1.892E+98	1.082E+888 1.082E+888 1.082E+888 1.082E+888 1.082E+888 1.082E+888	STAUCHAS	03 (175) 1.107E-81	AER 1 1.832E+88
7.419E+88 7.571E+88 7.571E+88 7.635E-88 7.689E-886 7.735E-886	Ĺ	1686 688 KM 1686 6886 KM 1687 6886 KM 1687 6886 KM 1687 6886 DEG 1687 6886 KM	4 <sup>2</sup> 4	MOL SCAT
3.242E 3.242E 3.242E 3.256E 4.88 3.155E 5.86 5.86 5.86 5.86 5.86 5.86 5.86 5.86	33.00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ωω 20 Ω	SEA LEVEL IUNA HZO (SCALE 1.144E+88	NZ CONT 3.262E+00
198 199 28 98 88 88 88 88 88 88 88 88 88 88 88 88	2	PACTOR PERSON	EQUIVALENT	

DIANCE(WATTS/CM2-STER-XXX)

アンファント はは 重日 というじょうしゅう はんしん はいしょう しょうしょう しかかけ なななな 美しない かいない 大変 国力のからない

																					C#-1
TOTAL	754	70	er.	797	796	7.94	796	8.01	. 8.843	808	905	8.04	802	803	. 8133	81	8.07	. 8.624	793	785	28.32
INTEGRAL	5.57E-86	5 1 F - 19	. 5.2E-19	.358-18	. 196 - 8	. Ø1E-B	.82E-B	6.9E-B	8.35E-85	8-3E-B	815-10	. 85E-B	13€ ~	. 20E-B	.28E-B	. 32E -B	396-1	1.45E-84	. 52E-B	.556-8	958 CM-1 -
(ADIANCE (MICRN)	1.51E-84	47F-6	356-8	. 27E-B	.27E-B	28E-	.27E-18	.24E-B	B-312.	.176-8	. 20E-B	. 20E-10	21E-	0-361'	. Ø9E - Ø	. 1.0E - 0	.12E-B	-	.21E-B	. 25E - B	85# TO
ATMOS RADI	2 235-86	9.55	. 81E-19	.67E-B	.66E-B	Ø-399	.62E-P	.56E-0	.5	. 4 SE - P	. 4 SE - P	. 4 SE - Ø	44E-0	41E-8	. 27E	.27E-B	. 28E-8	1.31E-06	.36E-B	.39E-0	TION FROM
VAVLEN	11.765	6	1.56	1 49	1.42	. 36	1.29	1.23	_:	-	1.05	8.98	. 92	18.87		Ø.75	69.8	10.638	85.0	6.52	IED ABSORPTI
FREG CCM-1)	95.0	n ts	•	~	<b>t</b> ∼	0	œ	ø	895.	•	0	10	_	28	925.	8	3	8	•	950	INTEGRAT

INTEGRALD ABSORPTION FROM BSB TO 558 CM-1 = AVERAGE TRANSMITTANCE = .7968

INTEGRATED PADIANCE = 1.555E-24 WATTS CH-2 STER-1
MINIMUM PADIANCE = 1.268E-86 WATTS CH-2 STER-1 (CM-1)-1 AT
MAXIMUM PADIANCE = 2.229E-86 WATTS CH-2 STER-1 4CM-1)-1 AT
BOUNDARY TEMPERATURE = 1.688
BOUNDARY EMISSIVITY = 1.688

CAPD 5 \*\*\*\*

17.46.51.UCLP, AA, LP2 , B.9

Table C-3

LOWTRAN OUTPUT FOR CASE 2

			•										
CARO 1	:	ψ	2		80	62	<b>5</b> 2	•	ba .	. 800	888		
CARD 2	:	7	8	<b>6</b> 0	80	В	Ð	-	888.	. 039	808.	8,	. 888
CARD 3	:	28	28.82	۳.	000.	180.000	H 9 9		១ភព:	សម្គម.	. 808	69	
CARD 4	:	850.000	OBO	950.036	881	'n	5.883						
PROGRAM	PROGRAM WILL COMPUTE RADIANCE	MPUTE	RALIA	JON									
CALCULA	CALCULATIONS WILE	.1	BONE	US INC	WULT	3741.	DONE USING MULTIPLE SCATTERING	ER 11	ā				
ATMOSPH	ATMOSPHERIC MODEL TEMPERATURE	EL TURE	•		1962	S n	U S STANDARD	0					
	WATER VAPOR OZGNE	APOR	• •		1962	SO	STANDARD	50					
AEROSOL	MODEL REGIME				AERO	SOL	AEROSOL TYPE			PROFILE			SEASON
	BOUNDARY LAYER (B-Z KM) TROPOSPHERE (2-10KM) STRATOSPHERE (10-30KM)	Y LAY HERE PHERE	'ER (8-2 KM (2-18KM) : (18-38KM)	Z KM)		OSPH GROU	RURAL TROPOSPHERIC BACKGROUND STRATO	ATO		5.8 KM VIS AT SEA LEVEL TROPOSPHERIC BACKGROUND STRATO	S AT SEA C STRATO	LEVE	SPRING-SUMMER SPRING-SUMMER
	UPPER ATMOS (38-188KM)	TMOS	(38-18	(BKM)	METE	ORIC	METEORIC DUST			NORMAL			
SLANT PATH. H1 H2 A20 AANGL BETA	ATH, HI. HZ ANGLE F RANGE V BETA X	E WW	28.688 . 888 . 888 . 688 . 988	X X Q X Q X Q X Q X Q X Q X Q X Q X Q X									
FREQUEN	FREQUENCY RANGE VI V2 - DV -		88.09 55.59 56.08	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<u> </u>		1.76 H	10.80	11.76 MICROMETERS!				

TABLE C-3 (Cont).

2.528E-83 2.528E-83	2.528E-#3 2.333E-#3 2.147E-#3	2.147E-#3 2.188E-#3 2.287E-#3	2,427E-83 3,313E-83 4,288E-83	5.867E-83 7.467E-83 7.933E-83	8,867E-#3 9,888E-#3 1,128E-#2	1,307E-02 1,493E-02 1,633E-02	1.773E-82 1.773E-82 1.828E-82	3.773E-82 1.689E-82 1.587E-82	9.333E-83 5.133E-83 2.287E-83	7.933E-84 1.867E-94 4.813E-86	2.9878-89
2.722E-84 2.471E-84	2.2386-84 2.8226-84 1.8236-84	1.638E-04 1.469E-84 1.313E-84	1.178E-84 1.848E-84 9.201E-85	8.113E-05 6.941£-05 5.932E-85	5,0785-05 4,3335-05 3,7035-05	3.156E-05 2.787E-05 2.314E-05	1.9786-85 1.685E-85 1.435E-85	1.224E-85 1.844E-85 8.918E-86	4.097E-06 1.884E-06 9.889E-07	4.375E-07 2.285E-07 1.948E-08	1.1116-18
9.475E-Ø1 9.601E-Ø1	7.789E-81 7.835E-81 6.348E-81	5.698E-21 5.108E-21 4.566E-81	4.869E-81 3.615E-81 3.199E-81	2.823E-B1 2.413E-B1 2.863E-B1	1.763E-01 1.507E-01 1.288E-01	1,101E-01 9,411E-02 8,045E-02	6.878E-02 5.859E-02 4.991E-02	4.256E-82 3.632E-82 3.181E-82	1.425E-82 6.55RE-83 3.891E-83	1.521E-03 7.945E-04 6.773E-05	3.861E-87
1.569E+2 7.951E+1	3.791E+19 1.46BE+19 5.454E+18	1.846E+18 J.5Ø8E+17 1.988E+17	6.490E+1 9.537E+1 1.460E+1	3.931E 6.178E 1.468E	3.18Ø6 2.3376 1.6776	1.219E+1 8.726E+1 8.726E+1	8.726E+1 1.038E+1 1.219E+1	1.464E+1 1.677E+1 1.963E+1	6.508E 1.154E 2.023E	4.615E+ 6.498E+ 1.014E+	4.507E+EB
7.378E-B 6.818E-B	4.878E-01 3.927E-01 3.158E-01	2.513E-Ø1 1.994E-Ø1 1.572E-Ø1	1.232E-8 9.586E-8 7.403E-8	5.6785-02 4.1508-02 3.8315-02	2.214E-02 1.617E-02 1.181E-02	0.637ff-03 6.311ff-03 4.6:2E-03	2.371E-03 2.451E-03 1.763E-03	1.299E-#3 9.483E-#4 6.929E-#4	1.479E-04 3.193E-05 7.318E-P6	1.821E-0 5.827E-0 3.291E-8	1.8465-13
2.4936-83 2.3876-83	2.294E-03 2.028E-03 1.774E-03	1.692E-83 1.576E-83 1.632E-83	1.645E-03 2.130E-03 2.557E-03	3.493E-03 4.037E-03 4.028E-03	4.229E-03 4.388E-03 4.719E-03	5,161E-03 5,540E-03 5,691E-03	5.803E-03 5.447E-03 5.248E-03	4.802E-03 4.274E-03 3.792E-03	1.642E-83 6.674E-84 2.227E-84	5.881E-#5 1.072E-#5 8.259E-#8	5.18ØE-12
9.285E-#1	6.474E-Ø1 5.371E-Ø1 4.435E-Ø1	3.646E-#1 2.982E-#1 2.427E-#1	1.963E-Ø1 1.579E-Ø1 1.262E-Ø1	1.882E-01 7.619E-02 5.788E-02	4.397E-02 3.340E-02 2.537E-02	1.929E-02 1.466E-02 1.114E-02	8.478E-183 6.486E-183 4.847E-183	3.675E-03 2.789E-03 2.119E-03	5.476E-04 1.429E-04 3.922E-05	1.157E-#5 3.747E-#6 4.66#E-#8	5.428E-12
5.758E-01	2.323E:01 1.302E-01 7.166E-02	3.745E-B2 1.992E-B2 9.834E-B3	5.004E-03 1.703E-03 5.894E-04	2.367E-04 9.275E-05 3.917E-05	1.587E~05 1.181E-05 8.687E-06	6.432E-196 4.725E-196 4.184E-196	3.564E-296 3.371E-296 3.168E-296	3.215E-26 2.863E-26 2.636E-26	7.612E-07 1.624E-07 3.549E-88	9.176E-89 1.939E-89 2.486E-12	1.502E-16
288.2	275.2 268.7 262.2	249.2	236.2	216.8 216.7 216.7	216.7	216.7 216.7 216.7	215.7 217.6 218.6	219.6 228.6 221.6	226.5 236.5 258.4	264.2 278.7 219.7	218.8
1013.000 898.800	795.888 781.288 616.588	540.500 472.200 411.100	356.500 308.000 265.000	227.888 134.888 165.888	141.708 121.108 183.588	89.500 75.650 64.670	55.298 47.298 48 478	34.578 29.728 25.498	11.978 5.746 5.871	1.491 .798 .855	. 688
. 88 1 . 88	2.88 3.88 4.88	5.88 6.38 7.88	8.80 9.06 19.06	11.88 12.98 13.88	14.88 15.82 16.88	17.88 18.82 19.82	28.88 21.88	23.88 24.88 25.88	38.68 35.68 48.88	45.88 58.88 79.88	100.00
- 2	w. 4. no	00 √ 80	0.69-1	132	15	18 19 28	21 22 23	2.4 2.5 2.6	27 28 29	3 1 1 2 2 2 2 2 3 3 1 1 2 3 3 3 3 3 3 3	33
	. BB 1213.888 288.2 5.7588-01 9.2858-81 2.4938-03 7.3788-81 1.5698-28 9.4758-81 2.7228-84 2.5288-88 1.888 898.888 281.7 3.7198-01 7.7718-81 2.3878-83 6.8188-01 7.9518-19 9.6818-81 2.4718-84 2.5288-8	. ## 1013.000 288.2 5.758E-01 9.285E-81 2.493E-03 7.379E-81 1.569E+20 9.475E-91 2.722E-84 2.528E-86 1.000 898.800 281.7 3.719E-01 7.771E-01 2.387E-03 6.010E-01 7.951E+19 8.601E-01 2.471E-04 2.520E-00 2.80 795.000 275.2 2.323E-00 6.474E-01 2.294E-03 4.070E-01 3.791E+19 7.789E-01 2.230E-04 2.520E-00 3.00 701.200 268.7 1.302E-01 5.371E-01 2.020E-03 3.927E-01 1.460E+19 7.035E-00 2.032E-04 2.333E-00 4.000 516.600 262.2 7.166E-02 4.435E-01 1.774E-03 2.150E-01 5.454E+19 5.340E-01 1.823E-04 2.147E-05	. 88 1813.888 281.7 3.758E-81 2.493E-83 7.378E-81 1.569E+28 9.475E-81 2.722E-84 2.528E-8 1.98 1813.888 281.7 3.719E-81 2.771E-81 2.387E-83 6.818E-81 1.569E+28 9.475E-81 2.771E-84 2.528E-8 2.888 281.7 3.719E-81 7.771E-81 2.387E-83 6.818E-81 7.951E+19 8.681E-81 2.731E-84 2.528E-8 2.888 281.7 3.719E-81 6.474E-81 2.234E-83 4.874E-81 3.791E+19 7.788E-81 2.238E-84 2.332E-8 2.	.89 1013.000 288.2 5.758E-01 9.285E-01 2.493E-03 7.378E-01 1.569E+20 9.475E-01 2.722E-04 2.520E-00 1.00 898.000 281.7 3.719E-01 7.771E-01 2.387E-03 6.010E-01 7.951E+19 8.601E-01 2.722E-04 2.520E-00 2.00 795.000 275.2 2.323E-01 6.474E-01 2.234E-03 4.870E-01 3.791E+19 7.788E-01 2.230E-04 2.333E-00 2.00 701.200 268.7 1.302E-01 5.371E-01 2.024E-03 4.870E-01 3.791E+19 7.035E-01 2.722E-04 2.333E-00 2.00 701.200 268.7 1.302E-01 5.371E-01 1.774E-03 3.927E-01 1.460E+19 7.035E-01 2.722E-04 2.333E-00 2.300 701.200 266.7 7.166E-02 4.435E-01 1.774E-03 3.150E-01 1.460E+19 7.035E-01 1.823E-00 2.337E-00 2.00 255.7 3.745E-02 2.046E-01 1.502E-03 2.513E-01 1.946E+19 5.509E-01 1.633E-00 2.147E-00 2.00 255.7 3.745E-02 2.092E-01 1.574E-03 2.513E-01 1.946E+10 5.690E-01 1.469E-01 1.1692E-00 2.00 2.00 2.00 2.00 2.00 2.00 2.00 2	1.88 1013.000 288.2 5.758E-01 9.285E-01 2.493E-03 7.379E-01 1.569E+20 9.475E-01 2.722E-04 2.520E-00 1.000 898.000 281.7 3.719E-01 7.771E-01 2.394E-03 4.076E-01 7.951E+19 0.601E-01 2.722E-04 2.520E-00 2.000 795.000 275.2 2.323E-01 6.474E-01 2.234E-03 4.070E-01 3.791E+19 7.780E-01 2.730E-04 2.333E-00 781.200 268.7 1.302E-01 5.371E-01 2.234E-03 3.927E-01 3.791E+19 7.780E-01 2.730E-04 2.333E-00 781.200 268.7 1.302E-01 5.371E-01 1.774E-03 3.927E-01 1.460E+19 7.780E-01 2.782E-04 2.137E-00 2.0000 2.000 2.000 2.000 2.000 2.000 2.000 2.000 2.000 2.000 2.000 2.0	1.88 1013.000 288.2 5.758E-01 9.205E-01 2.409E-03 7.378E-01 7.951E+19 0.475E-01 2.722E-04 2.520E-00 2.00 898.000 275.2 2.323E-01 7.771E-01 2.394E-03 4.874E-01 7.951E+19 0.601E-10 2.471E-04 2.520E-00 2.00 701.200 268.7 1.302E-01 7.771E-01 2.234E-03 4.874E-01 3.791E+19 7.788E-01 2.471E-04 2.332E-04 2.332E-00 2.00 701.200 268.7 1.302E-01 5.371E-01 2.234E-03 3.927E-01 1.469E+19 7.035E-01 2.722E-04 2.332E-00 2.00 701.200 268.7 1.302E-02 4.435E-01 1.774E-03 3.927E-01 1.469E+19 7.035E-01 2.722E-04 2.332E-00 2.00 701.200 268.7 1.302E-02 2.364E-01 1.774E-03 3.927E-01 1.469E+19 5.406E-01 1.638E-04 2.332E-00 2.00 7.00 411.180 26.00 2.00 2.00 2.00 2.00 2.00 2.00 2.	1.88 1013.888 281.2 5.758E-01 9.285E-01 2.493E-03 7.378E-01 1.569E-28 9.475E-01 2.722E-84 2.528E-8 1.88 898.888 281.7 3.719E-01 7.771E-01 2.397E-03 6.818E-01 7.951E+19 8.691E-01 2.475E-01 2.471E-84 2.528E-8 2.33E-8 2.89 795.888 261.7 1.382E-01 7.771E-01 2.234E-03 4.88 E-19 7.951E+19 7.88E-19 7.88E-91 2.472E-84 2.528E-8 2.33E-8 2.89 795.888 265.7 1.382E-01 5.425E-01 1.774E-03 3.927E-01 1.465E+19 5.348E-19 7.882E-01 1.872E-04 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.33E-8 2.32E-9 2.33E-8 2.	188   1813   1882   288   2   5   758   2   1   771   2   1   2   2   2   2   2   1   1	1.89   288.2   288.2   5.758E-01   9.285E-01   2.2877-03   6.018E-01   7.591E-01   9.601E-01   2.471E-04   2.520E-04   2.3877-03   6.018E-01   7.591E-01   2.471E-04   2.520E-04   2.3877-03   6.018E-01   7.788E-01   2.471E-04   2.520E-04   2.3937-04   2.300   795.800   255.2   2.1372E-01   6.741E-01   2.721E-01   2.	1.88 1813 888 887 281.2 5.758E-81 9.285E-81 2.493E-81 1.559E+28 9.475E-81 2.722E-84 2.528E-84 2 1.898E-88 2 1.898 888 888 888 888 888 888 888 888 888	1.88

TABLE C-3 (Cont).

~	OF ILES										
	e W	⊢ĝ	CNTMFRN MOLLOME KM	HND3 ATM CM/KM	AEROSOL (-)	1 AEROSOL 2	AEROSOL 3	AEROSOL 4 (-)	AER1*RH (-)	C189US (-)	RH (PERCNT)
	1013.880 898.880	288.2	2.838E+22 1.361E+22	. 850E+88 . 850E+88	7.780E-01	. 883E+88 . 888E+88	. 888E+88 . 888E+88	. BBBE+BB . BBBE+BB	3.533E+#1 3.777E+#1	. 888E+88	4.589E+#1 4.986E+#1
	795.888 781.288	1,75.1	S.143E+21	888E+88 .788E+88	6.210E-03 .009E+03	. MUSE+60	. NABE+FH . NABE+83	. 000E + 00	3.238E+08 .888E+08	. 888 E + 85	5.281E+81 .088E+88
	516.688 544.588	262.2	2.821E+21	. 888E+68	. 888E +88	1.850E-02 9.310E-03	. 7095+30 . JROE+40	. የፍሪድ + ወሰ . የየሪድ + ወሰ	. 000E+00 . 000E+00	. 828E+88	. ABBE+BB . ABBE+BB
	472.208	0.44 0.44 0.4	7.8252+28 3.472E+28	. 480E+88 . 486E+88	. 888E +88	7.710E-83 6.230E-83	. 8885 + 88 . 8885 + 88	. 880E+86 . 886E+86	. 883E+88 . 885E+88	. 882E+88	. ABBE+88
	356.50 <i>8</i> 388.888	236.2	1.768E+20 6.023E+19	4.869E-35	. 888E + 88	3.370E-03 1.820E-03	. 000E+88	. 8885 + 88	. 888E+88 .888E+88	. 868E+88	. 488E+88
	265.000 227.000	223.3 216.8	2.086E+19 8.384E+18	1.856E-85 2.258E-85	. 888E +88	. 888E+88	1.140E-03 7.990E-04	. 800E + 88	. 888E+88	. 888E+88	8885+88. 3886.
	194.000 165.800	216.7	3.235E+18 1.345E+18	2.896E-#5	. 000E+00 . 000E+00	. BBDE+BB	6.410E-04 5.170E-84	. 888E+88	. BRBE+BB . BRBE+BB	. 882E+368.	. 8886+88
	14:.788	216.7	5.364E+17 3.929E+17	2.820E+85 2.712E-85	. 880E + 88	. BROE + 88	4.420E-04 3.950E-04	. 888E+88	. 888E + 88	. BBEE+388.	. 888E+88
	183.568 88.508	216.7	2.845E+17 2.874E+17	2.446E-05 2.202E-05	. 888E + 98	. 885E + 28	3.828E-84 4.258E-84	. 888E+88	. 8888 - 88 . 8888 - 86	. 83 E E + 88	. 888E+88
	75.656 64.673 55.298 47.298 43.878	216.7 216.7 216.7 217.6 217.6	1.5886+17 1.242E+17 1.896E+17 1.819E+17 9.481E+16	1.976E-05 1.850E-05 2.063E-05 2.168E-05 2.096E-05	. 000E + 00 . 000E + 00 . 000E + 00 . 000E + 00	9695:+88 .988:+88 .988:+88 .986:+88	5.2006-84 5.918E-84 5.898E-84 5.020E-84	. 8485 + 98 . 8885 + 88 . 8885 + 86 . 8885 + 88	. 1999 E + 1999 . 1999 E + 1999 . 1996 E + 1999 . 1999 E + 1999	. 998EE + 998 . 998EE + 998 . 958EE + 988 . 958EE + 988 . 958EE + 988	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
	34.678 29.728	219.6 220.6	8.788E-16 8.825E+16	2.213E-05 2.179E-05	. 000E + 20	. 8985 + 99 . 8895 + 88	3.000E-04 1.980E-04	. 888E+88	. 888E+88	. 882E+98	. 2865+188
	25.498	221.6	7.414E+16 1.951E+16	1.178E-#5 3.784E-06	. 8885 - £8	. 888E+88	1.318E-84 3.328E-65	. 888E+88	. 888E+88 . 888E+83	. 8885 + 88 . 882 E + 88	. 888E+88
	5.746 2.871 1.491	236.5 25Ø.4 264.2	3.796E+15 7.502E+14 1.764E·14	1.441E-07 3.891E-37 .888E+88	. 888E + 88 . 888E + 88 . 888E + 28	. 6 × 3E + 88 . 808 E + 88 . 889 E + 88	. 888E+88 . 888E+88 . 888E+88	1.640E-05 7.990E-06 4.010E-85	. 888E +88 . 888E +88 . 888E +88	. BBEE+BB . BBEE+BB . BBEE+BB	. 888E+88 . 888E+88 . 388E+88
	. 798 . 855 . 888	27.03.7 219.7 21.03.03	3.454E+13 3.69BE+1B 1.399E+86	8885+88 .8885+88 .8885+88	. 888E + AB . 388E + AB . 888E + AB	. 888E+88 . 888E+88 . 888E+88	. 888E+88 . 888E+88 . 888E+£8	2.188E-86 1.688E-87 9.318E-18	. 888E+88 . 888E+88 . 888E+88	. 886E+88 . 886E+88 . 836E+88	. 838E+88 . 838E+88 . 938E+88
ũ	ж н1, н2.	ANGLE									

EITHER A SHORT PATH (LEN.Ø) OR A LONG PATH THROUGH A TANGENT HEIGHT (LEN.1) IS POSSIBLE: LEN

SLANT PATH PARAMETERS IN STANJARD FORM

TABLE C-3 (Cont).

TABLE C-3 (Cont).

						IABLE	. U−3 (	(Cont).					
	AR RHOBAR (		.49 1.17E-#3 .49 1.86E-83 .99 9.57E-84	99 9 63E 84 99 7 7E 84 58 6 98E 94 54 6 24E	.55 4 300 - 64 .55 4 450 - 64 .15 3 895 - 84	75 3,39E-34 70 2,89E-84 70 2,47E-84 78 2,11E-04	72 1.546-84 72 1.546-84 72 1.556-84	.78 9.62E-85	CNTMFRW JMOL CM-2)	1.187E+17 2.575E+17 4.347E+17	6.706E+17 1.0145+18 1.475E+18	2.355E+18 4.5ØBE+18 9.915E+18	2.360E+19 6.073E+19 1.690E+20
	PBAR TBA (MB) (K)		55.683 284 45.698 278 47.913 271	58.727 255 78.284 253 41.516 255	53, 677 039 32, 137 233 86, 399 226 45, 987 228	210.499 216. 179.900 216. 153.750 216. 131.460 216	12.398 216 96.888 216 82.875 216 78.168 216	59.980 216	CNTMSLF2 MOL CM-23	8.726E+11 1.745E+12 2.781E+12	4.217E+12 6.286E+12 8.942E+12	1.644E+13 4.912E+13 2.808E+14	9.367E+14 5.241E+15 3.411F+16
	BENDING (DEG)		9 988. 9 988.	2000 2000 2000 2000 2000 2000 2000 200	666 666 666 666 666 666 666 666 666 66	. 666 1 . 666 1 . 667 1	1 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	888.	CNTMSLF1 MOL CM-23 (1	.726E+11 .745E+12 .781E+12	.217E+12 .286E+12 .942E+12	.644E+13 .912E+13	.367E+14 .241E+15 .411E+16
	DBEND (DEG)		988. 988. 988.	998. 998. 968.	688. 688. 688.	909 900 900	998 938 988 988	. 888	N CW	13E-82 8 57E-62 1	9.06 - 92 4 3.06 - 92 6 6.38 - 0.2 8	73E-82 1 73E-82 4 15E-81 2	6666-01 9
	FH1 (DEC)		188.808 188.508 188.608	188.878 188.878 186.778 187.84	108.088 188.008 188.008	188.248 188.828 188.838 188.838	138.888 188.888 188.888	188.808	3 :	-85 1.78 -85 3.26 -85 4.666	-95 5.88 -94 6.93 -94 7.86	-54 8.78 -24 9.47 -54 1.81	- 84 1.86 - 84 1.186 - 84 1.18
	BETA (DEG)		. 976 978 978	5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	888 888 888	548. 548. 548.	999 909 999 999	. 266	HNO.	1.957E- 3.878E- 5.957E-	8.2776- 1.0366- 1.3626-	1.647E- 1.937E- 2.194E-	2.360E- 2.431E- 2.49F-
TMOSPHERE	DBETA (DEG)		୬୯୫ : ୬୭୫ :	308 308 308	698. 698.	200 200 200 200	. 868 . 886 . 886		1 TO Z 03 1TS)	5.747E-83 1.136E-82 1.671E-82	2,165K-#2 2,62#E-#2 3,051E-#2	3.463E-02 3.667E-02 4.243E-82	4.546E-82 4.788E-82 4.969E-82
UGH THE AT	RANGE		1.888 2.888 3.888 3.888	4.05.05.00 6.00.00 6.00.00 6.00.00 6.00.00 6.00.00	8.888 9.888 13.888	12.088 13.088 14.088	16.088 17.868 18.088 19.889	20.000	ATH FROM H COZ+ LOWTRAN UN	55E-83 57E-82 44E-82	63E-82 83E-82 93E-81	996-Ø1 656-Ø1 426-Ø1	696-81 835-81
ATH THROU	CRANGE		1.288 1.288 1.888	1.888 1.888 1.888 1.888	1.866 1.866 1.866	1.848 1.866 1.866	1.888 1.888 1.888		A THE PA O SCALED L	-46 9.7 -46 2.2 -45 3.9	-85 6.10 -85 9.81 -85 1.2	-85 1.7 -84 2.4 -94 3.3	1 1 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5
FRACTED P	THETA (DEG)		200 200 200	808 808 808	838 838 838	ତ୍ର ବର୍ଷ ବର୍ଷ ବର୍ଷ ବର୍ଷ ବର୍ଷ ବର୍ଷ ବର୍ଷ ବର	888 888 888	<b>6</b> 0	MOUNTS FO	3.828E- 8.235E- 1.377E-	2.127E- 3.144E- 4.518E-	7.997E- 1.331E- 2.868C-	6.734E- 1.723E-
OF THE RE	17UDE 70 18 K	i o	988 988 3. 488	4.00 9.00 9.00 9.00 9.00 9.00 9.00 9.00	9 . 8 . 8 . 8 . 8 . 8 . 8 . 8 . 8 . 8 .	12.688 13.668 14.886	16.888 17.862 18.888	20.400	BSORBER A	216.78 216.78 216.78	216.78 216.78 216.78	216.78 216.78 216.75	220.18 226.18
CULATION	A MONTO	, (1	888 C	64 C 4	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	12.688 13.688 14.668	15.848 15.868 17.888 18.088	990 · 61	ULATIVE A	19.000 18.000 17.000	16.000 15.000 14.000	13.600 12.000 11.000	10.00 0.00 0.00 0.00 0.00
C≱FC	Ħ		~ () (h	≪run vor⊷	⊕ ο, #. π. π. π.	1111 H	9		T C	<b>~</b> ∨¤	4 የአ ናው	₩ <b>01</b> 02	<b>89</b> – A
							C-19						

TABLE C-3 (Cont).

.768E+21 .285E+21 .339E+22	.378E+22 .887E+22												
5.812E+18 3.1.288E+19 7.2.918E+19 1.	5.649E+19 2.9.131E+19 4.		<i>ಇವರಿನ</i>	ବ୍ୟବ୍ୟ	ବ୍ୟବ୍ୟ	D.T. (1.10)	2020				CNTMFRN	(NOL CM-2)	4.8878+22
. #12£ + 19 . 43#£ + 19 3.873E + 19	1.489C+19	CIRRUS	. 888E + 88 . 888E + 88 . 888E + 88 . 888E + 88	. 90.9E + 98. . 90.9E + 98. . 90.9E + 98.	. 8886 + 98 . 886 + 98 . 886 + 98 . 888 + 98	. 838E+38 . 638E+28 . 838E+28 . 838E+36	. 0000 + 3000 . 0000 + 900 . 0000 + 900 . 0000 + 9000				CHIMSELES	(Z-WO TOW)	9.1316+19
1.221E-#1 5 1.243E-#1 1 1.267E-#1 3	1.293E-Ø1 9 1.318E-Ø1 2	AER 4	. 8886 - 88 . 888 - 88 . 888 - 88 . 888 - 88	. 888E + 88 . 868E + 88 . 868E + 88	. 898E+88 . 888E+88 . 888E+88	. 888E+88 . 888E+88 . 888E+88 . 888E+88	. DEFE+8A . ABBE+3B . BFEE+BB . PBEE+BB				CNTMSLFI	THOL CM-2) (	2.8875.20
2.449E-84 2.449E-84 2.449E-84	2.449E-04 2.449E-04	AEP 3	5.856E-64 1.136E-43 1.688E-43 2.012E-43	2.480E-83 2.618E-83 3.297E-83 3.873E-83	4.598E-83 5.558E-83 6.128E-83 6.128E-83	6.120E-03 6.120E-03 6.120E-03 6.120E-03	6.128E-03 6.128E-83 6.128E-83 6.128E-83				03 114	(ATM CH)	1.318E-01
5.638E-82 5.819E-82 6.834E-82	6.258E-02 6.512E-02	AER 2	. 959E + 66 . 959E + 56 . 959E + 38	. 000E+38 . 009E+98 . 608E+88 . 988E+88	.000E+99 .000E+99 9.100E-04 3.426E-83	8.8886-83 1.5826-82 2.3516-82 3.6896-82	6.2618-82 7.9918-82 7.9918-82 7.9918-02				HNO3	(ATM CM)	2.449E-04
1.986E+88 2.475E+98 3.865E+88	3.776E+80	AER :	. 2552 E + 338 . 2536 E + 336 . 2536 E + 337 . 3530 E + 337	. 1985 - 488 . 1985 - 488 . 689 - 488 . 689 - 488	. 868E+88 . 668E+88 . 668E+88	. BBBE+88 . RBBE+88 . RBBE+88 . BBBE+88	.020E+52 3.105E-82 3.122E-91 1.082E+80			RHOUNTS	03	UNITS	6.5128-02
1.867E-81 2.847E-81 3.811E-81	6.778E-21	MOL SCAT	7,446E-02 1,616E-03 2,635E-03 3,826E-93	5,2215-81 6,8525-81 8,7615-81 1,0995-88	1.361E+BB 1.661E+BB 2.882E+BB 2.385E+BB	2,817E+88 3,588E+88 3,848E+88 4,441E+88	5.109E+88 5.85E+88 6.668E+88 7.571E+88	כשוכפו	29.000 KM 80.000 KM 20.000 NEG 20.000 NEG 900 KM 9000 KM	OTAL ABSORBER	c02+	ED LOWTRAN UI	4.626E+8@
258.99 1 265.49 2 271.99	78.49	N2 CONT	3.959E-#3 9.376E-#3 1.679£-#2 2.693E-#2	8.9816-82 5.9816-82 6.5826-82 1.2146-82	1.702E-81 2.352E-81 3.197E-81 4.286E-81	5.681E-81 7.4566-81 9.7886-81 1.2528-81	1,6242+00 2,6426+00 2,5856+00 3,2526+00	ME GEOMETRY (	A A A A A A A A A A A A A A A A A A A	EA LEVEL T	Q 27 #	ISCALE	1.1445+88
4.0000 3.0000 2.0000 2.0000	1 688 659	( KM)	19.088 18.088 17.668	15.282 14.882 13.786 12.688	11.788 18.688 9.888 8.888	7.888 6.886 5.886 4.688	999. 999. 999.	-	E E E E E E E E E E E E E E E E E E E	OUIVALENT SE			
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MEAN RH (PRCNT)	48.25
CIRRUS	. 888E+08
AER 4	.8661+88
AER 3	6.1285-83
AER 2	7, 9915-82
AER 1	1.882E+88
MOL SCAT	7.5716+88
N2 CONT	3.252E+98

CASE 20: GIVEN HI, HZ, BETA:

TERATE	AROUND	ANGLE UNTIL	BETA CONV	CONVERGES		
ar ui 	ANGLE (DEG)	85.A (DEG)	OBETA (DEG)	RANGE CKM	HHIN KM	PH1 (DEG)
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BENDING (DEG) (RR) (G

SLANT PATH PARAMETERS IN STANDARD FORM

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TABLE C-3 (Cont).

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TABLE C-3 (Cont).

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3.357E+11 1.883E+12	7.827E+12 9.647E+12 1.122E+13	1.256E+13 1.369E+13 1.464E+13	1.552E+13 1.639E+13 1.742E+13	1,886E+13 2,885E+13 2,359E+13	3.188E+13 6.376E+13 2.154E+14	9.514E+14 5.255E+15 3.413E+16	1.537E+17 5.349E+17 1.681E+18	5.012E+18 1.288E+19 2.918E+19	5.649E+19 9.131E+19	Sn	888 886 866 866	488 888 888	0 10 10 10 10 10 10 10 10 10 10 10 10 10	<b>888</b> 888 888	88
3.377E+11 1.885E+12	7.829E+12 9.649E+12 1.122E+13	1.256E+13 1.369E+13 1.465E+13	1.552E+13 1.639E+13 1.743E+13	1.886E+13 2.885E+13 2.359E+13	3.188E+13 6.376E+13 2.154E+14	9.514E+14 5.255E+15 3.413E+16	1.537E+17 5.349E+17 1.681E+18	5.@12E+18 1.43ØE+19 3.873E+19	9.489£+19 2.087E+20	CIRR	7	# 3888E + # 888E	. 0000E+	. 1988 1986 1986 1986 1986	. GOBE+
.772 <b>E-8</b> 2 .284 <b>E-6</b> 2	.244E-81 .487E-81 .588E-61	.768E-01 .939E-01 .117E-01	.2875-01 .4435-01 .5835-81	.785E-81 .818E-81 .983E-81	.987E-81 .864E-81 .132E-81	.183E-#1 .221E-#1 .249E+#1	.235-81 .2955-81 .3166-81	.337E-01 .36FE-01 .384E-01	. 4345-31	AER 4	9.272E-87 1.688E-85 3.876E-85 5.963E-85	1.591E-8 1.591E-8 1.591E-8	1.59   E   1.59   E	1.5936-84 1.5936-84 1.5936-84	1.5916-04
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.659E-#4 2.826E-#:	.8325-82 2.1886-8 .8325-82 2.511E-8 .3536-82 2.9646-8	.776E-82 3.466E-8 .335E-82 4.901E-8 .874E-82 4.563E-8	.849E-82 5.138E-8 .331E-82 5.780E-9 .818E-82 6.235E-8	.237E-62 6.728E-87 .216E-81 7.183E-97 .688E-81 7.614E-57	.186E-81 8.827E-8 .772E-81 8.438E-8 .649E-81 8.887E-3	.7766-91 9.1896-0 .1916-01 9.3438-0 .9558-81 9.5328-0	.014E+8P 9.656E-8. .284E+BP 9.856E-0. .614E+8P 1.8R2E-0	.585E+88 1.819E-8 .585E+88 1.858E-8	.896E+80 1.893E-8 .657E+88 1.187E-8	i ai	99999	20 20 20 20 20 20 20 20 20 20 20 20 20 20	999E	996 996 996	3 <i>0</i> 0
.436E-#7 5.559E-#4 2.625E-# .482E-#6 2.#72E-#3 8.238E-#	.003E-85 7.878E-83 2.188E-8. .275E-85 1.072E-82 2.511E-8. .566E-85 1.353E-82 2.954E-8	.875E-85 1,776E-82 3,465E-8 .282E-85 2,335E-82 4,981E-# .546E-85 3,874E-82 4,563E-9	931E-#5 4.849E-#2 5.138E-# .372E-#5 5.33E-#2 5.788E-# .925E-#5 7.818E-#2 6.235E-#	.676E-85 9.237E-82 6.728E-8 .693E-85 1.216E-81 7.183E-81 .867E-85 1.688E-81 7.614E-8	.646E-85 2.186E-81 8.438E-8 .586E-54 2.772E-81 8.438E-8 .123E-24 3.649E-81 8.887E-8	9895-04 4,7766-91 9.1895-0 -215-03 6,1916-81 9.3435-0 -8116-23 7.9555-81 9.5326-0	.1965-62 1.014E+8P 9.656E-8 .6255-02 1.284E+8P 9.856E-8 .487E-82 1.614E+8P 1.982E-6	.0.185-01 2.5056+80 1.0196-0 .0.186-01 2.5056+80 1.0386-0 .0116-01 3.0056+80 1.0606-0	.7785-81 3.8965-80 1.8935-8 .1446-68 4.6576-88 1.1876-8	ER 1 AE	9996-488 . 6696 9987-488 . 6986 9986-488 . 6986	3055 - 305 - 305	999E+999 .000E 999E+999 .999E 959E+999 .999E	6685+69 .0605 6995+99 .2905 8495+96 .8895 8485+98 .9605	388+88 . 883E
52 5.436E-#7 5.659E-#4 2.826E-#: 82 2.482E-#6 2.472E-#3 8.238E-#:	993E-85 7.878E-83 2.188E-8 275E-85 1.832E-82 2.511E-8 566E-85 1.353E-82 2.954E-8	89 1.875E-85 1.776E-82 3.465E-8 89 2.262E-85 2.335E-82 4.981E-8 14 2.546E-85 3.874E-82 4.563E-8	7# 2.931E-#5 4.049E-#2 5.138E-# 7# 3.372E-#5 5.331E-#2 5.789E-# 7# 3.925E-#5 7.818E-#2 6.235E-#	70 5.693(F-85 9.237E-82 5.728E-8 70 5.693(F-85 1.216E-81 7.183E-8 70 ".267E-85 1.688E-81 7.614E-8	78 9-646E-05 2-186E-01 8-82-E-07 72 1.586E-02 2.772E-01 8-436E-03 75 5.123E-024 3.649E-01 8-887E-03	9895-04 4,7766-91 9,1895-0 1255-03 6,1915-81 9,3435-0 8115-23 7,9555-81 9,5325-0	5P 1.1955-02 1.0148-8P 9.6956-09 3P 2.6255-02 1.2848-8P 9.8566-0 5P 5.4758-02 1.6148-8P 1.8925-0	90 1.007E-01 2.505E+88 1.019E-0 49 2.046E-01 2.505E+88 1.038E-0 99 3.011E-01 3.005E+88 1.060E-0	49 6.778E-81 3.886E+81 1.893E-8 99 1.144E+88 4.657E+88 1.187E-8	OL SCAT AER I AE	534E-89 3.912E-84 .888E+88 .888E 996E-86 6.294E-83 .8885+88 .888E 117E-86 1.189E-82 .888E+88 .888E 588E-85 2.296E-82 .888E+88 .888E	.866E-84 4.599E-82 .888E+88 .88RE .866E-84 9.551E-92 .888E+88 .88RE .253E-83 2.833E-81 .888E+88 .88RE .957E-83 2.359E-81 .888E+88 .88RE	.224E-91 .999E+98 .999E .224E-91 .999E+98 .999E .765E-91 .959E+99 .999E .498E-91 .689E+99 .999E	.465E-92 5.145E-81 .888E+88 .889E .087Z-22 6.016E-81 .888E+88 .289E .18E-92 7.035E-81 .888E+88 .889E .763E-02 8.227E-81 .888E+88 .880E	.150E-01 9.621E-81 .808E+88 .888E
42.52 5.436E-#7 5.659E-#4 2.826E-#: 3#.82 2.482E-#6 2.472E-#3 8.238E-#:	23.73 1.883E-85 7.878E-83 2.188E-8 21.89 1.275E-85 1.832E-82 2.511E-8 28.89 1.566E-85 1.353E-82 2.964E-8	89 1.875E-85 1.776E-82 3.465E-8 89 2.262E-85 2.335E-82 4.981E-8 14 2.546E-85 3.874E-82 4.563E-8	.898 216.78 2.931E-85 4.849E-82 5.138E-8 .888 216.78 3.372E-85 5.331E-82 5.788E-9 .888 216.78 3.925E-85 7.818E-82 6.235E-8	.888 216.78 4.676.85 9.2376-82 6.7286-8 .888 216.78 5.638-85 1.216E-81 7.1836-9 .888 216.78 3.638-85 1.688E-81 7.6146-8	.888 216.78 9.646E-85 2.186E-81 8.827E-89 .888 216.78 1.586E-84 2.772E-81 8.438E-8 .808 216.75 3.123E-84 3.649E-81 8.887E-8	.000 220.10 6.9895-04 4.7766-91 9.1895-0 .00 256.55 1.000-03 6.1916-01 9.2435-0 .000 233.00 4.8116-23 7.9555-01 9.5326-0	7 239.56 1.1965-62 1.0145+88 9.6965-8 7 245.20 2.6265-02 1.2845+88 9.8546-8 8 252.56 5.4725-82 1.614E+88 1.842E-8	.898 265.49 2.448E-01 2.817E+08 1.819E-0 .888 271.99 3.811E-01 3.896E+08 1.868E-0	49 6.778E-81 3.886E+81 1.893E-8 99 1.144E+88 4.657E+88 1.187E-8	2 CONT WOL SCAT AER I AE	098 9.5348-69 3.9188-84 .6888-83 .6888 038 1.9968-86 6.2948-83 .8888-88 .0888 038 7.1178-86 1.1898-82 .8888-89 .8888 .888 2.6888-85 2.2968-82 .8888-88 .8888	. 486 1.164E-04 4.599E-22 .888E+88 .66EE .668 4.866E-84 9.551E-92 .888E+88 .86EE .668 2.253E-83 2.833E-81 .888E+89 .86FE .888 3.957E-83 2.369E-81 .888E+89 .88fE	4.181E-83 2.762E-91 .889E+98 .899E 5.718E-83 3.224E-91 .869E+98 .899E 7.669E-83 3.765E-81 .858E+98 .899E 1.878E-82 4.488E-91 .688E+98 .899E	.000 1.465E-02 5.145E-91 .000E+99 .000E .000 2.007E-02 6.016E-91 .000E+99 .000E .000 2.46E-02 7.035E-91 .000E+98 .000E .000 3.763E-02 8.227E-81 .000E+98 .000E	.150E-01 9.621E-81 .808E+88 .888E

TABLE C-3 (Cont).

	5 C C C C		CNTMFRM	(MOL CM-2)	4.887E+22	MEAN RH (PRCNT)	48.25
	. 868E : 489 . 5018E : 489 . 868E + 489 . 868E : 481		CNTMSLF2	(BOL CM-2)	9.1316+19	CIRRUS	. BBBE + IB
1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E 1.5991E	. 593 E - 84 1.593 E - 084 1.593 E - 84 1.593 E - 84		CNTMSLF1	(MOL CM-2)	2.0875+20	AEP 4	1.591E-84
5.694E-83 6.594E-83 6.798E-93 7.759E-93 8.378E-83 8.378E-83 8.328E-93 8.328E-93 8.328E-93 8.328E-93	88.12888 6.13886 6.13886 7.288 88.1388 88.1388 88.1388 88.1388		03 UV	(ATH CM)	3.4345-81	AER 3	8.3285-03
. 9998 E + 99 9998 E + 99 99 1 999 E + 99 99 1 998 E + 99 3 4 2 6 E + 93 2 5 8 9 E E + 93 2 5 8 9 E E + 23 2 5 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 6 8 9 E + 23 2 7 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	6.261E-82 7.991E-82 7.991E-82 7.991E-82		HN03	(ATM CM)	3.876E-04	AER 2	7.991E-Ø?
60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	. 0000 E + 00 3.105E - 02 3.125E - 01 1.082E + 00	S.L.N.D.ONN	03	175)	1.187E-81	AER 1	1.882E+00
2	.5536.00 5.5456.00 .5536.00 6.2966.00 .5955.48 7.1688.89 .2626.90 8.0126.00 GCOMETRY CALCULATION	188.888 KM 188.888 KM 188.888 KM 188.888 KM 188.888 KM 1888 KM 1888 KM 1889 DEG 1889 DEG 1880 REG 1880	+200	(SCALED LOUTPAN UNITS)	4.657E+RB	MOL SCAT	8.Ø12E+ØA ]
7.851E-82 9.652E-82 1.35E-81 1.35E-81 3.34E-81 4.393E-01 7.555E-81 7.555E-81 7.555E-81	1.5156.60 2.5536.00 2.5955.40 3.2626.60 THE GCOMETRY	6	H20	SCALE	1.1448+88	NZ CONT	3.2628+20
8848	13.88 0.00 0.00 0.00 0.00 0.00 0.00 0.00	H1 H2 H3 RAMGE BETA PH1 PH1 PH1 PEN 1 CEN			-		1-7
ままな しころこ ころここの はちょう	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	ŭ					

	•	TOTAL	. 7544 . 7627 . 7727 . 7066	2007 2007 2007 2007 2007 2007 2007 2007	. 88884 . 88553 . 8928 . 8928 . 8133	.8116 .8879 .8824 .7932	28.32 CM-1	R-1 R-1 (CM-1)-1 A R-1 (CM-1)-1 A
	M2-STER-XXX	INTEGRAL	2.59E-05 7.75E-85 1.29E-84 1.88E-84	2.39E-94 2.91E-84 3.30E-84 3.80E-84 4.29E-84	5.26E-84 6.21E-84 6.68E-84 7.14E-84	9. 9556-984 9. 946-984 9. 386-884 9. 596-884	958 CM-1 =	CM-2 STE S CM-2 STE S CM-2 STE
	E (WATTS/C	IANCE (MICRN)	7.49E-04 7.54E-04 7.58E-04 7.63E-04	7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00 7.00.00	7.83E-134 7.83E-134 7.83E-134 7.84E-134 7.95E-134	7.85E-84 7.83E-84 7.82E-84 7.79E-84		968 93E-84 WATTS 99E-36 WATTS 37E-85 WATTS 28B-28 K
	RADIANC	ATMOS RAD	1.046-05 1.036-05 1.026-05 1.025-05	1.01E+05 1.00E-05 9.96E-06 9.80E-06 9.80E-06	9.64E-26 9.55E-26 9.46E-26 9.36E-26 9.27E-86	9.875-86 8.965-86 8.85E-66 8.73E-86	N FROM	ANCE = .7 CE = 9.3 CE = 8.5 TY = 1.89
		WAVLEN (MICRN)	11.765 11.696 11.628 11.561	11.494 11.364 11.299 11.299	11.111 11.858 18.989 18.929 18.878	186.7.3 186.63 186.638 186.582 187.562	160	RANSMIT D RADIA ADIANCE TEMPERA EMISSIV
		FRED (CM-1)	88 88 88 88 88 88 88 88 88 88 88 88 88	99999999999999999999999999999999999999	99 99 99 99 99 99 99 99 99 99 99 99 99	00000000000000000000000000000000000000	TEGRA	AVERAGE T INTEGRATE MINIMUM R MAXIMUM R BOUNDARY
-								
				(	C-25			

CARD 5 \*\*\*\*

TABLE C-4

LOWTRAN OUTPUT FOR CASE 3

	. 888	80		. 888.					SEASON	SEA LEVEL SPRING-SUMMER O SPRING-SUMMER						
. 435	888 888	866 . 838		. 888					PROFILE	5.9 KM VIS AT SEA TROPOSPHERIC BACKGPOUND STRATO NORMAL						
	. 684	. 684		. 888			ERING	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	PRO				DEG EAST OF NORTH DEG GREENVICH TIME DEG EAST OF NORTH			MICROMETERS) MICROMETERS)
<b>1</b> 10 10 10 10 10 10 10 10 10 10 10 10 10	8 8 8	N 88.	bq.	88 · BBB	18.88B	LAR SCATTERNG	USING MULTIPLE SCATTERING	1962 U S STANDARD 1962 U S STANDARD 1962 U S STANDARD	AEROSOL TYPE	RURAL TROPOSPHERIC BACKGROUND STRATO METFORIC DUST		ETERS SUMMARY	. 20 88 DEG 6.30 . 20 88 DEG . 40 88 GREE . 40 88 DEG	SUM	ш И	អ្នក ស.ភ.
2 2	8 8	. 898 28.880		.033 68.683	18.833 18268.888	JTE RADIANCE+SOLAR	BE DONE USING	# # # លលល		BOUNDARY LAYER (#-2 KM) TROPOSPHERE (2-10KM) STRATOSPHERE (10-30KM) UPPER ATMOS (30-100KM)	112 . 8888 KM 28 . 688 KM . 688	CONTROL PARAMETERS	TIVE AZIMUTH ** 1 ZENITH ** ( < 0 UNDEF) ** AZIMUTH ** 3F THE YEAR **	SOURCE IS THE SL	OM MIE DATA BASE	18128.9 CM-1 18268.9 CM-1
CARD 1 **** 6	CARD 2 ***** 2	CARD 3 ****	CARD 3A1 **** 2	CARD 3A2****	CARD 4 **** 18168	PROGRAM WILL COMPUTE	CALCULATIONS WILL	ATMOSPHERIC MODEL TEMPERATURE WATER VAPOR 020NE	AEROSOL MODEL REGIME	BOUNDARY L TROPOSPHES STRATOSPHE UPPER ATMC	SLAN FATH, HI TO HI HI HI ANGLE RANGLE BETA LEN	SINGLE SCATTERING	RELATIVE AZIMUTH SOLAR ZENITH = 1 TIME (30 UNDE) + PATH AZIMUTH = DAY OF THE YEAR	EXTRATERRESTIAL SC	PHASE FUNCTION FROM	FREQUENCY RANGE VI = V2 =

TABLE C-4 (Cont).

	3 (UV)	.520E-83 .520E-83 .528E-83	3336-83 1476-83	188E-83 287E-83	.313E-#3 .2005-63 .8675-#3	.467E-83 .933E-83 .867E-83	.888E-#3 .128E-#2 .387E-#2	. 493E-82 . 633E-82 . 773E-82	.773E-W2 .828E-#2	.680E-82 .587E-82	.133E-83 .287E-03 .933E-84	.867E-84 .813E-86 .887E-89
	N-1 03	2.774E-84 2 2.519E-64 2 2.281E-64 2	2.861E-84 2 1.857E-84 2 1.67BE-84 2	1.497E-84 2 1.338E-84 2 1.192E-64 2	1.059E-04 3 9.376E-05 4 8.272E-05 6	7.073E-85 7 6.045E-85 7. 5.166E-85 8	4.415E-05 9. 3.774E-05 1. 3.227E-05 1	2.758E-05 1 2.358E-05 1 2.016E-05 1	1.717E-85 1 1.463E-85 1 1.247E-85 1	1.864E-85 1 9.888E-86 1 4.175E-86 9	1.928E-86 5. 9.859E-87 2.	2.3285-87 1 1.9855-98 4 1.1325-18 2
	MOL SCAT	9.475E-31 8.6Ø1E-61 7.788E-Ø1	7.835E-81 2 6.348E-81 1 5.638E-81	5.188E-81 4.566E-81 4.869E-81	3.615E-Ø1 3.199E-Ø1 2.823E-Ø1	2.413E-01 2.863E-01 1.763E-01	1.587E-81 1.288E-81 1.181E-81	9.411E-#2 8 8.845E-#2 6.878E-#2 2	5.859E-#2 1 4.991E-#2 1 4.256E-#2 1	3.632E-#2 3.1#1E-#2 1.425E-#2	6.558E-83   3.891E-83   1.521E-83	7.945E-84 6.773E-85 3.861E-87
	CMTMSLF MOL/CM2 KM3	1.569E+20 7.951E+19 3.791E+19	1.468E+19 5.454E+18 1.846E+18	5.588E+17 1.988E+17 6.498E+16	9.537E+15 1.46ØE+15 3.031E+14	6.178E+13 1.468E+13 3.188E+12	2.337E+12 1.677E+12 1.219E+12	8.726E+11 8.726E+11 8.726E+11	1.038E+12 1.219E+12 1.464E+12	1.677E+12 1.963E+12 6.588E+11	1.354E+11 2.023E+18 4.615E+09	6.49BE+88 1.814E+85 4.587E+98
	N2 (	7.378E-81 6.818E-81 4.878E-81	3.927E-#1 3.15@E-#1 2.513E-#1	1.994E-81 1.572E-81 1.232E-91	9.586E-#2 7.4#3E-#2 5.678E-#2	4.158E-82 3.831E-82 2.214E-82	1.617E-#2 1.181E-#2 8.637E-#3	6.311E-#3 4.612E-#3 3.371E-#3	2.451E-03 1.783E-09 1.299E-03	9.483E-84 6.929E-04 1.479E-04	3.193E-#5 7.318E-#6 1.821E-#6	5.827E-87 3.291E-89 1.846E-13
	RAN UNITS	2.4930-03 2.3876-83 2.2846-03	2.828E-83 1.774E-83 1.692E-83	1,576E-83 1,632E-83 1,645E-83	2.138E-83 2.557E-83 3.493E-83	4.837E-83 4.828E-83 4.228E-83	4.388E-#3 4.71#E-#3 5.161E-#3	5.548E-83 5.691E-83 5.883E-83	5.447E-83 5.248E-83 4.882E-83	4.274E-83 3.792E-83 1.642E-83	6.674E-84 2.227E-84 5.881E-85	1.072E-05 8.259E-08 5.180E-12
	SCALED LOUT	9.285E-#1 7.771E-#1 6.474E-#1	5.3716-#1 4.435E-#1 3.646E-#1	2.982E-01 2.427E-01 1.963E-01	1.579E-#1 1.262E-#1 1.882E-#1	7.619E-#2 5.788E-#2 4.397E-#2	3.348E-82 2.537E-82 1.929E-82	1.466E-02 1.114E-02 8.470E-03	6.486E-83 4.847E-83 3.675E-83	2.789E-83 2.119E-83 5.476E-84	1.429E-84 3.922E-85 1.157E-85	3.747E-86 4.658E-88 5.428E-12
	H20 (SC	5.758E-81 3.719E-81 2.323E-81	1.382E-81 7.166E-82 3.745E-82	1.992E-#2 9.834E-#3 5.884E-#3	1.703E-03 5.894E-04 2.367E-04	9.275E-#5 3.917E-#5 1.587E-#5	1.181E-#5 8.687E-#6 6.432E-#6	4.726E-86 4.184E-86 3.564E-86	3.371E-86 3.168E-86 3.815E-86	2.8 <i>8</i> 3E-86 2.636E-86 7.612E-87	1.624E-87 3.549E-88 9.176E-89	1.939E-89 2.486E-12 1.582E-16
	+9	288.2 281.7 275.2	268.7 262.2 255.7	242.7	229.7 223.3 216.8	216.7 216.7 216.7	216.7 215.7 216.7	216.7 216.7 216.7	217.6 218.6 219.6	220.6 221.6 226.5	236.5 258.4 264.2	278.7 219.7 210.8
PROFILES	9 (8 P	1813.888 898.888 795.888	781,288 616,688 548,588	472.238 411.188 356.588	368.089 265.000 227.000	194.002 165.868 141.788	121.188 183.588 88.588	75,658 64,678 55,298	47.298 48.478 34.678	29.728 25.498 11.978	5.746 2.871 1.491	798 .055 .088
MOSPHERIC	2 (KM)	. 88 1.88 2.88	3.00 1.00 1.00 1.00 1.00 1.00	6.88 7.82 9.88	9.55	12.88 13.88 14.88	15.88 16.88 17.88	18.88 19.68 28.88	21.88 22.88 23.98	24.80 25.88 38.88	35.88 48.83 45.88	58.68 78.88 180.88
ATMOS	~	~~~	<b>4</b> €0	V 69 Q	9-12	13	16 17 18	2.0 2.1 2.1	232	25 26 27	28 38	31 32 33

TABLE C-4 (Cont).

RH ERCNT)	89E+Ø1	9868+81 2818+81 8888+88 8888+88 8888+88	88E+88 88E+88	888E+88	89E+88	88E+88 88E+88	885 + 88 885 + 88	88E+88 8PE+88	00E+89 88E+83 88E+88	38E+88 88E+88	88:+388	08E+88 09E+08 88E+88	985+88 885+88	90E+08
TRRUS (-)	888E+88 4.5	888E+88 - 2 888E+88 - 6 888E+88 - 6 888E+88 - 8 888E+88 - 8	888E+88 . 8	88 88 5 + 28 8 . 8 . 8 . 8 . 8 . 8 . 8	8885 + 88 . 81 8885 + 88 . 81	BOSE+BO . 81 BBOE+OB . 81	BUSE+88 .3	882E+88 . 0	8888 + 88	888E+88 . F	8.88E+88 888E+88	888E+88 . 88888888888	888E+88 .8 888E+88 .8 888E+88 .F	8. 68.388B
AEF1*RH C	. 5338+01	777E+81 238E+88 .888E+88 .988E+86 .888E+88	. 888E+88 .	. 8885 • 88 .	. 888E+88	. 8885+83	. 8885 + 88	. 000E+00	. 088E+98 . 088E+88 . 888E+88	. 8885+88	. 888E+88 .	. 888E+88 . 888E+88 . 888E+88	. 888E + 88 . 888E + 88	. 080E+80
AERGSOL 4	. 000E+00	.000E+58 3 .000E+58 3 .000E+58 .000 .000E+89 .000E+89	. 088E+38	. 000E+00	. 888E+88	. 838E+38	. 888E+88	. 808E+88	. 888E+88 . 888E+88 . 888E+88	. BOSE+BB	. 8335 + 88 . 8885 + 83	.008E+60 1.648E-05 7.998E-86	4.8185-86 2.1885-86 1.5885-87	9.3101-18
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1 AER350L 2	. BROE+BB	. 860E + 88 3.460E - 82 1.850E - 82 9.310E - 83 7.718E - 83	6.230E-03 3.370E-03	1.820E-103 .000E+100	. 888E+85	. 848E+48	. 888E+88	. 888E + 88	. 888E + 88 . 888E + 68 . 880E + 88	. 888E + 88	. 000E+00	. 888E+88 . 888E+88 . 888E+88	. 888E+88 . 888E+88 . 888E+88	BOOE+OB
AEROSOL (-)	7.780E-01	7.780E-01 6.210E-02 .000E+08 .000E+08 .000E+08	. 888E +88	. 888E + 88	. 800E+80	. 888E + 88	. 888E + 88	. BBRE + BB . BBBE + BP	. 888E +89 . PPBE +98 . 888E +88	. 888E+88	. 888E + 88	. 888E + 88 . 888E + 88 . 88BE + 88	. 898E + 88 . 898E + 88 . 898E + 88	. BBBE+83
HNO3 ATM CM/KM	. 000E+00	. 888E + 86 . 888E + 86 . 888E + 86 . 888E + 88 . 888E + 88	. 888E+88	3.615E-Ø6 1.855E-Ø5	2.258E-05 2.896E-05	2.888E-05 2.820E-05	2.712E-85 2.446E-85	2.282E+85 1.976E-85	1.858E-85 2.063E-05 2.168E-05	2.8955-85 2.2135-85	2.179E-05 1.178E-05	3.784E-86 1.441E-87 3.891E-37	. 888E + 88 . 888E + 68 . 888E + 68	BB+BBB.
CNTMFRN MOL/CM2 KM	2.010E+22	1.3016+22 9.143E+21 4.573E+21 2.521E+21 1.319E+21 7.025E+20	3.472E+28 1.768E+28	6.023E+19 2.086E+19	8.384E+18 3.235E+18	1.345E+18 5.364E+17	3.923E+17 2.845E+17	2.87'E+17 1 588E+17	1.282E+17 1.836E+17 1.819E+17	9.401E+16 8.788E+16	8.8255+16 7.414E+16	1.96!E+16 2.796E+15 7.582E+14	1.764E+14 3.454E+13 3.688E+18	1.399E+#6
⊢ĝ	288.2	281.7 275.2 268.7 262.2 255.7	242.7	229.7	216.8 215.7	216.7	216.7	7.912	216.7	218.6 219.6	228.6 221.6	226.5 236.5 258.4	264.2	216.8
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ATMOSPHERIC PROFILES

CASE 2A: GIVEN HI, HZ, ANGLE



TABLE C-4 (Cont).

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4.8975+2	4.087E+2 4.087E+2 4.807E+2	4.887E+2													
9.1316+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19	ľ۸	0	ದು ಕಾ ಆ ಘ	<i>000</i> 00		750b	ଷ୍ଟ୍ର					CNTMFR4 (MOL CM-2)	4.887E+22
2.887E+2#	2.087E+28 2.087E+28 2.087E+29	2.8878+78	CIRRUS	, none + B.	. 000E+8 . 000E+8 . 000E+8	60066+8666 80066+8666 80066+86666 80066+86666	. 000E+08 . 000E+80 . 000E+80	. 888E + 88 . 888E + 88 . 888E + 88	. 099E+8 089E+8 . 689E+8					CNTMSLFZ (MD: CM-2)	9.1316+19
7.298E-#2	8.512E-82 9.912£-82 1.148E+81	1.3185-£1	AER 4	. 88AE - 8B	. 899E + 88 . 890E + 98 . 899E + 99 . 899E - 50	. 2085; +88 . 6486; +88 . 2885; -58 . 3896; -58	. 888E+88 . 888E+88 . 888E+88 . 888E+88	. 888E + 88 . 888E + 88 . 888E + 88	. BBBE+BB . BBBE+BB . BBBE+BB					CNTMSLF1	2.887E+28
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.144E+BB 4	.144E+88 4 .144E+88 4	. 1445+00 4	MOL SCAT	9.031E-01	1,722E+8B 2,462E+8B 3,131E+8B 3,732E+8B	4.272E+88 4.755E+88 5.185E+88 5.578E+88	5.91 <i>BE+88</i> 6.211E+88 6.472£+88 6.695E+88	6.886E+88 7.849E+88 7.389E+88	7.410E+000 7.497E+000 7.571E+000	CALCULATION	. 283 KM	. #08 DEG . #08 KM . #08 DEG B. #08 DEG . #08 DEG	AL ABSORBER	COZ+	4.526E+80
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TABLE C-4 (Cont).

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SLANT PATH PARAMETERS IN STANDARD FORM
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TABLE C-4 (Cont).

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RANGE DBETA	_		• •		. 888	• •	•	9.000	• •	•	14.000 .000	988		3.888	22.000 .000 23.000 .000	4.886		•		•	. 808.	H1 T0	UNITS)	(440	œ
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E RANGE	(KH)		1.0000 10.0000 10.0000 10.0000	4 45 50 50 50 50 50 50 50 50 50 50 50 50 50	5.888	6.888 7.088	8 .888	9.0000	11.668	12.088	14.000	16.808	18.656	29.888	22.098	24.886	35.00.00	48.888	45.888	78.888	188.888	H1 T0	UNITS)	(440	œ
E RANGE	(KH)		1.0000 10.0000 10.0000 10.0000	4 45 50 50 50 50 50 50 50 50 50 50 50 50 50	5.888	6.888 7.088	8 .888	9.0000	11.668	12.088	14.000	16.808	18.656	29.888	22.098	24.886	35.00.00	48.888	45.888	78.888	188.888	PATH FROM HI TO	CO2+ LOWTRAN UNITS)	8.586E-81 2.448E-83 1.561E+88 4.775E-83 2.151E+88 6.924E-83	
E RANGE	_		986	4 45 50 50 50 50 50 50 50 50 50 50 50 50 50	5.888	. 666	8 .888	9.000	888 11.888	988 12.088	• • •	16.808	888	29.888	2.888 3.888	.686 24.886		. 868 48.868	. 888 45.888	. 686 78.686	. 848 158.888	PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	.561E+88	. 548E+8B 8.
	(KH)		1.0000 10.0000 10.0000 10.0000	4 45 50 50 50 50 50 50 50 50 50 50 50 50 50	5.888	6.888 7.088	8 .888	9000 0 0000 9000 10 1000	888 11.888	988 12.088	888 15.888 .	16.808	18.656	29.888	888 22.888	.686 24.886	35.00.00	. 868 48.868	45.888	. 686 78.686	188.888	THE PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	1 8.586E-81 2 1 1.561E+88 4 1 2.151E+88 E	2.54BE+#B 8.
DRANGE	(KH)		1.0000 10.0000 10.0000 10.0000	4 45 50 50 50 50 50 50 50 50 50 50 50 50 50	5.888	6.888 7.088	8 .888	9000 0 0000 9000 10 1000	888 11.888	988 12.088	888 15.888 .	16.808	18.656	29.888	888 22.888	.686 24.886		. 868 48.868	. 888 45.888	. 686 78.686	. 848 158.888	THE PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	.21 8.586E-81 2 .81 1.561E+88 4	2.54BE+#B 8.
DRANGE	(KM) (KM) (		1.888 1.888 1.888 2.888 1.888 3.888		888 5 888	1.688 6.888	1.000	1. 1966 G G 6068	1.888 11.888	1.988 12.088	1.888 14.888	1.868 16.888	1.888 18.888 1.888 10.888	1.888 28.888	1.888 23.888	1,888 24.888	1. 18 18 18 18 18 18 18 18 18 18 18 18 18	5.868 48.868	5, 888 45, 888 5, 888 58, 888	25.688 78.888	38.888 188.888	PATH FROM HI TO	CO2+ D LOWTRAN UNITS)	.21 8.586E-81 2 .81 1.561E+88 4	2.54BE+#B 8.
DRANGE	(KM) (KM) (		1.0000 10.0000 10.0000 10.0000		888 5 888	6.888 7.088	1.000	9000 0 0000 9000 10 1000	1.888 11.888	1.988 12.088	888 15.888 .	1.868 16.888	18.656	1.888 28.888	888 22.888	1,888 24.888		5.868 48.868	. 888 45.888	25.688 78.888	. 848 158.888	FOR THE PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	.21 8.586E-81 2 .81 1.561E+88 4	2.54BE+#B 8.
E RANGE	(KH)		1.888 1.888 1.888 2.888 1.888 3.888		888 5 888	1.688 6.888	1.000	1. 1966 G G 6068	1.888 11.888	1.988 12.088	1.888 14.888	1.868 16.888	1.888 18.888 1.888 10.888	1.888 28.888	1.888 23.888	1,888 24.888	1. 18 18 18 18 18 18 18 18 18 18 18 18 18	5.868 48.868	5, 888 45, 888 5, 888 58, 888	25.688 78.888	38.888 188.888	FOR THE PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	.21 8.586E-81 2 .81 1.561E+88 4	.837E+88 2.548E+8B 8.
DRANGE	(KM) (KM) (		1.888 1.888 1.888 2.888 1.888 3.888		888 5 888	1.688 6.888	1.000	1. 1966 G G 6068	1.888 11.888	1.988 12.088	1.888 14.888	1.868 16.888	1.888 18.888 1.888 10.888	1.888 28.888	1.888 23.888	1,888 24.888	1. 18 18 18 18 18 18 18 18 18 18 18 18 18	5.868 48.868	5, 888 45, 888 5, 888 58, 888	25.688 78.888	38.888 188.888	FOR THE PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	1 8.586E-81 2 1 1.561E+88 4 1 2.151E+88 E	2.54BE+#B 8.
DRANGE	(KM) (KM) (		. 286 1 886 1 988 . 286 1 689 2 986 . 399 1 689		988 5 888 5 886	. 333 1.888 5.888 . 330 1.888 7.888	. 8 96. 1 960. 1 960.	. අතර 1 . කළුතු ර කළුතු	. 980 11.888 11.888	. 882 1.888 12.888 888 1.888	. 468 1.888 14.848	. 600 1.868 16.888	. 450 1.450 18.450 . 450 1.560 18.450	. 882 1.888 28.888	. 686 1.888 22.888 . 687 1.888 23.888	. 000 1.800 24.800	. 2557 1. 2555 7. 12. 2555 3	. 688 5.868 48.888	. 2017 5. 2020 45. 2020 . 201 5. 2020 52. 2020	. 696 25.696 78.898	. ଜନ୍ମ   38.୭୫୫   1୫୫.୫୫୫	FOR THE PATH FROM HI TO	H20 CO2+ (SCALED LOWTRAN UNITS)	4.664E-21 8.586E-81 2.631E-83 4	1.837E+88 2.648E+88 8.
THETA DRANGE RANGE	(DEG) (KM) (KM) (		. 286 1 886 1 988 . 286 1 689 2 986 . 399 1 689		988 5 888 5 886	. 333 1.888 5.888 . 330 1.888 7.888	. 8 96. 1 960. 1 960.	. අතර 1 . කළුතු ර කළුතු	. 980 11.888 11.888	. 882 1.888 12.888 888 1.888	. 468 1.888 14.848	. 600 1.868 16.888	. 450 1.450 18.450 . 450 1.560 18.450	. 882 1.888 28.888	. 686 1.888 22.888 . 687 1.888 23.888	. 000 1.800 24.800	. 2557 1. 2555 7. 12. 2555 3	. 688 5.868 48.888	. 2017 5. 2020 45. 2020 . 201 5. 2020 52. 2020	. 696 25.696 78.898	. ଜନ୍ମ   38.୭୫୫   1୫୫.୫୫୫	FOR THE PATH FROM HI TO	H20 CO2+ (SCALED LOWTRAN UNITS)	4.664E-21 8.586E-81 2.631E-83 4	.837E+88 2.548E+8B 8.
THETA DRANGE RANGE	(DEG) (KM) (KM) (				988.2 888 5.888	. 400 . 404 1.409 6.080	. 888. 8 988. 1 988. 8.888	. අතර	. 200 1.888 11.888	1997 1982 1.988 12.988		. 688 . 868 1.868 16.888		. 686 1.688 28.888	. 1000 . 1000 1 . 1000	000 1.00¢ 1.000 24.000	2002 . 2004 1. 2009 7.5. 2008	800 600 5.808 40.808	. 888 6 5.888 45.888 . 888 5.888 58.888	. 988 . 78.888 78.888	. ଅଷ୍ଟ . ଜନ୍ମ ଓଷ୍ଟ ଅଷ୍ଟ ଅଷ୍ଟ ଅଷ୍ଟ	FOR THE PATH FROM HI TO	COZ+ ED LOWTRAN UNITS)	4.664E-21 8.586E-81 2.631E-83 4	.49 1.837E+88 2.548E+88 8.
THETA DRANGE RANGE	(DEG) (KM) (KM) (	ea a	. 286 1 886 1 988 . 286 1 689 2 986 . 399 1 689		988.2 888 5.888	. 333 1.888 5.888 . 330 1.888 7.888	. 888. 8 988. 1 988. 8.888	. අතර 1 . කළුතු ර කළුතු	. 200 1.888 11.888	1997 1982 1.988 12.988	200	. 688 . 868 1.868 16.888	. 450 1.450 18.450 . 450 1.560 18.450	. 888 92 888 1 .888 28 .888	. 686 1.888 22.888 . 687 1.888 23.888	000 1.00¢ 1.000 24.000	. 2557 1. 2555 7. 12. 2555 3	800 600 5.808 40.808	. 2017 5. 2020 45. 2020 . 201 5. 2020 52. 2020	8.888 .888 28.888 78.888	. ଅଷ୍ଟ . ଜନ୍ମ ଓଷ୍ଟ ଅଷ୍ଟ ଅଷ୍ଟ ଅଷ୍ଟ	FOR THE PATH FROM HI TO	BAR H20 CO2+ (K) (SCALED LOWIRAN UNITS)	4.664E-21 8.586E-81 2.631E-83 4	1.837E+88 2.648E+88 8.
THETA DRANGE RANGE	(DEG) (KM) (KM) (	0 m O L			988.2 888 5.888	. 400 . 404 1.409 6.080	. 888. 8 988. 1 988. 8.888	. අතර	. 200 1.888 11.888	1997 1982 1.988 12.988		. 688 . 868 1.868 16.888		. 888 92 888 1 .888 28 .888	2.000 .088 1.882 22.888 3.000 .088 1.882 22.888 3.000 .088 1.808 23.888	000 1.00¢ 1.000 24.000	2002 . 2004 1. 2009 7.5. 2008	800 600 5.808 40.808	5. <i>888</i> 858 5.888 45.888 8.888 880 5.888 58.888	8.888 .888 28.888 78.888	. ଜନ୍ମ   38.୭୫୫   1୫୫.୫୫୫	FOR THE PATH FROM HI TO	BAR H20 CO2+ (K) (SCALED LOWIRAN UNITS)	.21 8.586E-81 2 .81 1.561E+88 4	.49 1.837E+88 2.548E+88 8.
TITUDE THETA DRANGE NANGE	(KM) (KM) (	D I	1.000 .000 1.000 1.000 2.000 .000 .000 2.000		8.000 S.000	5.400	. 256.8 356.1 959. 958.8	. කමත වැඩසිය වැඩසිය මෙත කම : කමත 1 කමත මෙ 1 කාර් 1 කමත	11.000 .000 1.000 11.000	12.888 888 1.888 12.868	14.000 .000 1.000 1.000 15.000 .15.000	16.000 .000 1.000 16.000	17.000 . 000 1.000 18.000 19.0	28.889 .886   .888 29.888	23.000 .000 1.000 23.0000 .	24.000 .000 1.000 24.000	. 1998 -	48.800 . 000 S.80B 48.80B	45. <i>888 .888</i> 5.888 45.888	78.988 .800 25.888 78.888	3 188.888 .880 38.888 188.888	THE PATH FROM HI TO	BAR H20 CO2+ (K) (SCALED LOWIRAN UNITS)	284.99 4.664E-21 8.586E-91 278.49 7.631E-21 2.151E+888 6	265.49 1.837E+88 2.648E+88 8.
LITTUDE THETA DRANGE RANGE	(KM) (DEG) (KM)	0	1.000 1.000		8.000 S.000	5.400	. 486.8 946. 1.966. 8.868.	අත පාරා දෙන යන 1 කොම කර කර කර ක	88 11.698 .860 1.888 11.688	12.888 888 1.888 12.868	14.000 .000 1.000 1.000 15.000 .15.000	16.000 .000 1.000 16.000	17.000 . 000 1.000 18.000 19.0	28.889 .886   .888 29.888	23.000 .000 1.000 23.0000 .	24.000 .000 1.000 24.000	. 1998 -	48.800 . 000 S.80B 48.80B	45. <i>888 .888</i> 5.888 45.888	78.988 .800 25.888 78.888	3 188.888 .880 38.888 188.888	ABSORBER AMDUNTS FOR THE PATH FROM HI TO	TBAR H20 CO2+ (K) (SCALED LOUTRAN UNITS)	284.99 4.664E-21 8.586E-91 278.49 7.631E-21 2.151E+888 6	265.49 1.837E+88 2.648E+88 8.
LITTUDE THETA DRANGE RANGE	(KM) (DEG) (KM)	D I	.000 1 000 .000 1 000 1 000 0 000 0 000 0 000 0 000 0 000 0 000 0		888 S 686 . 986 5.888	. 188 6.400 . 188 1.488 6.488	. 256 8.566 . 556 1.666 8.568	. අතුරු කුරු	. 688 11.698 . 660 1.888 11.688	.888 12.888 .888 1.888 12.888	. 488 14.024 . 468 1.884 14.666	. 22 16 889 870 1.888 16 808		. 863 26 886 . 886 1.888 26 888 .	. 1986 - 2. 1989 - 1883 - 2. 1986	. 088 24.868 . 386 1.888 24.886	. 고등 원인 : 조리 : 조리 : 조리 : 조리 : 조리 : 조리 : 조리 : 조	988 48.888 5.888 48.888	. ଉପରେ 45. ଅପରେ . ପ୍ରମ 5. ଅପରେ 45. ଅପରେ . . ଅପରେ 58. ଅପର 5. ଅପରେ 58. ଅପରେ .	. 968 76.988 . 698 25.888 78.888	. 886 188.888 . 880 38.888 188.888	ABSORBER AMDUNTS FOR THE PATH FROM HI TO	TBAR H20 CO2+ (K) (SCALED LOUTRAN UNITS)	808 284.99 4.664E.21 8.506E.91 2.898 278.49 7.631E-81 1.561E+88 4 888 271.99 9.394E-81 2.151E+88 E	.49 1.837E+88 2.548E+88 8.
LITTUDE THETA DRANGE RANGE	(DEG) (KM) (KM) (	D I	1.000 1.000		888 S 686 . 986 5.888	5.400	. 256 8.566 . 556 1.666 8.568	අත පාරා දෙන යන 1 කොම කර කර කර ක	. 688 11.698 . 660 1.888 11.688	.888 12.888 .888 1.888 12.888	14.000 .000 1.000 1.000 15.000 .15.000	. 22 16 889 870 1.888 16 808	17.000 . 000 1.000 18.000 19.0	9 663 28 886 . 666 1. 668 28 868	23.000 .000 1.000 23.0000 .	. 088 24.868 . 386 1.888 24.886	. 1998 -	988 48.888 5.888 48.888	45. <i>888 .888</i> 5.888 45.888	. 968 76.988 . 698 25.888 78.888	3 188.888 .880 38.888 188.888	ABSORBER AMDUNTS FOR THE PATH FROM HI TO	TBAR H20 CO2+ (K) (SCALED LOUTRAN UNITS)	284.99 4.664E-21 8.586E-91 278.49 7.631E-21 2.151E+888 6	265.49 1.837E+88 2.648E+88 8.
LITTUDE THETA DRANGE RANGE	(KM) (DEG) (KM)	D I	.000 1 000 .000 1 000 1 000 0 000 0 000 0 000 0 000 0 000 0 000 0		888 S 686 . 986 5.888	. 188 6.400 . 188 1.488 6.488	. 256 8.566 . 556 1.666 8.568	. අතුරු කුරු	. 688 11.698 . 660 1.888 11.688	.888 12.888 .888 1.888 12.888	. 488 14.024 . 468 1.884 14.666	. 22 16 889 870 1.888 16 808		9 663 28 886 . 666 1. 668 28 868	7.876 22.080 .082 1.888 22.886 1.266 22.080 .082 1.888 23.886 .	. 088 24.868 . 386 1.888 24.886	. 고등 원인 : 보면 : 1 : 보면 : 보면	988 48.888 5.888 48.888	. ଉପରେ 45. ଅପରେ . ପ୍ରମ 5. ଅପରେ 45. ଅପରେ . . ଅପରେ 58. ଅପର 5. ଅପରେ 58. ଅପରେ .	. 968 76.988 . 698 25.888 78.888	. 886 188.888 . 880 38.888 188.888	ABSORBER AMDUNTS FOR THE PATH FROM HI TO	TBAR H20 CO2+ (K) (SCALED LOUTRAN UNITS)	808 284.99 4.664E.21 8.506E.91 2.898 278.49 7.631E-81 1.561E+88 4 888 271.99 9.394E-81 2.151E+88 E	265.49 1.837E+88 2.648E+88 8.
LITTUDE THETA DRANGE RANGE	(KM) (DEG) (KM)	D I	.000 1 000 .000 1 000 1 000 0 000 0 000 0 000 0 000 0 000 0 000 0		888 5 888 1 986 300 5 888 7	. 188 6.400 . 188 1.488 6.488	. 888.8 9.86.1 969. 698.8 8.888	. අතුරු කුරු	18.888 11.888 11.888 11.888	11.888 12.885 , 882 1.888 12.888	. 488 14.024 . 468 1.884 14.666	15.088 16.888 .800 1.868 16.808		19.00.2 20.00.00.00.00.00.00.00.00.00.00.00.00.0	7.876 22.080 .082 1.888 22.886 1.266 22.080 .082 1.888 23.886 .	23.988 24.888 .886 1.888 24.886	. 고등 원인 : 보면 : 1 : 보면 : 보면	35.688 48.888 . 886 5.868 48.888	. ଉପରେ 45. ଅପରେ . ପ୍ରମ 5. ଅପରେ 45. ଅପରେ . . ଅପରେ 58. ଅପର 5. ଅପରେ 58. ଅପରେ .	5.8.968 78.888 .003 25.888 78.888	. 886 188.888 . 880 38.888 188.888	FOR THE PATH FROM HI TO	TBAR H20 CO2+ (K) (SCALED LOUTRAN UNITS)	808 284.99 4.664E.21 8.506E.91 2.898 278.49 7.631E-81 1.561E+88 4 888 271.99 9.394E-81 2.151E+88 E	265.49 1.837E+88 2.648E+88 8.

CALCULATION OF

TABLE C-4 (Cont).

3.817E+22 3.915E+22	3.965E+22 3.99ØE+22 4.ØØ1E+22	4.885E+22 4.885E+22 4.887E+22	4.887E+22 4.887E+22 4.887E+22	4.007E+22 4.007E+22 4.007E+22	4.887E+22 4.887E+22 4.887E+22	4.887E+22 4.887E+22 4.887E+22	4.887E+22 4.887E+22 4.887E+22	4.887E+22 4.887E+22	4.887E+22						
8.963E+19	9.115E+19 9.127C+19 9.138E+19	9.1316+19 9.1316+19 9.1316+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 9.131E+19	9.131E+19 9.131E+19 5.131E+19	9.131E+19 9.131E+19						
2.871£+20 2.882£+20	2.086£+28 2.987£+28 2.887£+28	2.087E+20 2.087E+20 2.087E+20	2.887E+28 2.887E+28 2.887E+28	2.887E+2# 2.887E+2# 2.887E+2#	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28 2.887E+28	2.087E+20 2.887E+20 2.887E+20	2.887E+28 2.887E+28 2.887E+28	2.887E+28 2.887E+28	CIRRUS	. 886E + 88 . 886E + 86 . 886E + 68	. 008E+186 . 008E+186 . 008E+186 . 008E+186	. 680E + 88 . 880E + 88 . 880E + 68	. 656E + 656 . 666E + 656 . 666E + 666 . 666E + 666	. PBRE+#B
	101010	141414	141414	141415	101012				10.0	-	889	38.	9 9 9 9	6665	ij.ij.+
. 185E-#2	. 617E-82 . 852E-82 . 139E-82	.515E-82 .828E-82 .785E-82	.475E-82 .315E-82 .248E-82	.598E-82 .512E-82 .912E-82	.148E-81 .318E-91	.675E-81 .854E-81	. 198E - 01 . 806E - 01 . 157E - 01	. 484E-81	. 4346-81	AER	. 8988 . 8988 . 8988 . 8988	. 999E . 999E . 999E	. 69 69 E	989E.	ena.
	~ ~ ~	<b>6</b> 6 6 6	<b>4.</b> ™ ™	<b>~</b> ∞ o		2	2000	ოოო	mm	m	89 53 53 63 69 53 53 63 69 53 53 53 53	5 0 5 B	90 90 90 90 4 10 10	20 00 00 00 00 00 00 00	83
. 888E+88	.888E+88 2.834[-35 1.887E-06	3.893£-86 2.546£-#5 5.123E-Ø5	8.815E-85 1.887E-84 1.363E-84	1,621E-84 1,853E-84 2,862E-84	2,253E-84 2,449E-04 2,651E-84	2.874E-84 3.889E-84 3.389E-84	3.4726-84 3.8216-04 3.8756-84	3.8765-84 3.8765-84 3.8765-84	3.876E-04 3.876E-04	AER	. 8666. . 8686. . 8686.	. BRBE + . BBBE +	.8886E+ 5.786E- 1.529E- 2.247E-	2.8236- 3.3826- 3.7286- 4.1886-	4.512E-
	••••		<b>W</b>	- 111	,,,,,,,,	.4.,.,	.,.,,,		1717	~	2000	9999	9 6 6 5	9955	30
.855E-82	.379E-#2 .543E-#2	.966E-02 .268E-02	.848E-82 .461E-82 .832E-82	.347E-#2 .84#E-#2 .375E-#2	.937E-82 .512E-82	.689E-82 .111E-82	.967E-82 .825E-81	.899E-81 .186E-81 .187E-81	. 187E-81 . 187E-81	AER	. 886E+ . 808E+ 1.738E- 4.382E-	5.648E- 6.488E- 7.183E- 7.648E-	7.988E- 7.991E- 7.991E-	7.991E- 7.991E- 7.991E-	7.9915-
3.843E+88 1 3.373E+88 1	3.643E+88 1 3.861E+88 1 4.839E+88	4.179E+86 1 4.292E+88 2 4.388E+88 2	4,446E+888 3 4,497E+888 3 4,535E+888 3	4.565E+000 4 4.587E+000 4 4.684E+000 5	4.616E+## 5 4.626E+## 6 4.634E+## 7	4.639E+88 8 4.643E+88 8 4.647E+88 8	4.649E+88 8 4.655E+88 1	4.657F+00 1 4.657E+00 1 4.657E+00 1	4.657E+8B	AER 1	7,7846-81 1,651E+88 1,882E+88 1,882E+88	1.8825+98 1.8825+38 1.0825+98 1.9825+98	1.882E+88 1.882E+88 1.882E+88 1.882E+88	1.4826+88 1.4826+88 1.4826+88 1.4826+88	1.0828+88
3E+36	2E+88	4E+00	45+88 45+88 45+88	4E+093 4E+033 4E+033	4E+8A 4E+8B 4E+8B	44E+8B 44E+8B 44E+8B	4 E + 0 0 4 E + 0 0 4 E + 0 0	4E+84 4E+34 4E+34	4E+06	DL SCAT	. 222E+88 . 462E+88	.732E+8B .272E+8B .755E+8B	. 578E+88 . 918E+88 . 211E+88	695E+84 886E+84 849E+84	388E+86
6.1		777	11.	444	777		777	4	7	£	ちょころ	€0.44 PD	ունանա	9000	7
258.99 1 252.58 1	246.488 239.58 1 233.88	226.55 1 220.18 1 216.75 1	216.7# 1 216.7# 1 216.7# 1	216.78 1 216.78 1 216.78 1	~ ~	218.89 219.89 1 228.89	233.72	242.52 256.43 367.89	283.15	יום ממאי	ع د، به ح		2.932E+88 3.816E+88 3.001E+88 3.138E+88	3.1456+88 3.1456+88 3.116+68 3.1556+88	• 1
5.888 6.888	5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5	12.688 11.688 12.688	13.898 14.888 15.288	16.288 17.888 18.288	9.61	22.000 23.000 24.000	ruceru General	84 85.88 888.88 888.88	300.001	11 <del>2</del> E			69 62 59 52		17.820
<b>6</b> 0 (2)	, κο.	==:	545	91.8		22	25 26 27	28 38	323	•>	~!!!!	n d t to	<b>6. 19</b> - 13	6.55	۲.

					CNTMFRW CM-21		MEAN RH (PRCNT)	48.25			
. 898E+88 . 688E+88 . 886E+58	. 008E > 80 . 088E + 88 . 088E + 88	. 808E + 88 . 809E + 88 . 408E + 86 . 408E + 86	098 + 3950 . 008 + 3900 . 008 + 3900 .		CNTMSLF2	316+1	CIRRUS	. BBBE+PB			
、京学者E 〜 部盤 、日本書E 〜 部盤 、日本書E + 日本	. 6985 + 88 . 6985 + 88 . 6985 + 88 . 4965 + 88	. 8885 (+88 . 886 (+88 4. 1986 (-85 9. 948 (-85	1.283E-84 1.431E-84 1.582E-84 1.591E-94		CRTMSL	2.887E+28	AER 4	1,591E-84			
4.984E-#3 5.535E-#3 6.126E-#3	6.664E-83 7.124E-83 7.481E-83 7.726E-83	7.858E-83 8.245E-93 8.328E-93 8.328E-93	8 . 328E - 8 8 . 3		03 UV	(ATH CH) 3.434E-B1	AER 3	8,3286-03	MOLECULAR PHASE F	E 6 6	)
7.991E-#2 7.991E-#2 7.991E-#2	7.991E-82 7.991E-82 7.991E-82	7.991E-82 7.991E-82 7.991E-82 7.991E-82	7.9918 7.9917 7.99.7		H	3.876E-84	AER 2	7.991E-82	SCITR MOLE ANGLE PHAS	68.86 .748E-81 68.86 .748E-81 68.88 .748E-81	68.887 .748E- 68.88 .748E- 68.88 .748E
1.8825+\$\$ 1.5825+\$\$ 1.5825+\$\$	1.082E+## 1.082E+## 1.882E+8# 1.882E+##	1、68255+8661、68255+8661、68255+86611、68255+86611、68255+86611	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8		AMOUNTS 03	1.107E-81	AER 1	1.892E+88	ATHS RELATIVE H AZIMUTH	~	اده است پست
7、41版E+8等 7、497E+6等 7、571E+68		rerer r		2	TUTAL ABSORBER CO2+	A.657E+##	MOL SCAT	8.1125+58	SCATTERING POINT TO SOURCE PATHS SCTTR SUBTENDED SOLA PATH RELATIVE ALT ANGLE ZENITH ZENITH AZIMUTH	58.83 .88 66.83 .88 67.23	68.89 67.89 88.99 88.99
3.242E+## 3.248E+## 3.258E+##	, www.m			A TO TO TO TO TO TO TO TO TO TO TO TO TO	SEA LEVEL	(SCAL	N2 CONT	3.262E+##	TTERING POIN R SUSTENDED ANGLE	888	
	- พพพร	i Neine	H AND CO		EQUIVALENT				SINGLE SCA SCITA SCIT POINT ALT		4 70 A

## TABLE C-4 (Cont).

					46 <b>C</b>		COL				
	TOTAL	.2828	.2816	.2811	. 2887 . 2865	.2883 .2888	.2797	.2794	.2783	.2777	
	INTEGRAL (CM-1)	1.53E-86	7.63E-80 1.87E-85	1.37E-85 1.68E-85	1.98E-85 2.295-85	2.59E-#5 2.98E-#5	3.20E-05 3.51E-05	3.81E-@5	4.425-85 4.734-25	4.88E-£5	
	ADIANCE (MICRN)	1.08E-82 1.08E-82	1.88E-82 1.88E-82	1.88E-02 1.88E-82	1.88E-82 1.81E-82	1.01E-02 1.51E-32	1.01E-02 1.01E-02	1.81E-82 1.01E-82	1.825-82 1.825-82	1.82E-02	
	TOTAL RA	3.85E-#7 3.85E-87	3.05E-07 3.05E-07	3.85E-87 3.85E-87	3.85£-87 3.85£-87	3.056-87 3.856-87	3.85E-87	3.85E-87 3.85E-87	3.86E-87 3.86E-87	3.86E-B7	
	IADIANCE DIRECT (CM-1)	.08E+98	. 58E+193	. 88E + 88	. 88E+88	. OSE + BB	. 88E +88	. 88E + 88	. 88E + 88 . 88E + 88	. 805 + 85	
	FLECTED # AL (MICRN)	. 88E +86 . 88E +88	. 88E+88	. BBE+BP . BBE+88	. 88E+86	. 88E+88	. PBE + BP	. 88E+88	. 88E + 88 . 88E + 88	69+348.	
	CM-12	. 1785 + 178 . 1785 + 198	. 88E+88	. #BE+36	. 885 + 588 . 885 + 88	. 88E + 08	. 885 + 385 . 885 + 885	. 88E+88	. 88E+88	.00+340.	
	NTTS/CMZ-STER	8.595-58 8.585-18	8.87E-88 8.87E-88	8.86E-88 8.95E-88	8.84E-58 8.535-68	8.83E-28	8.82E-88 3.82E-88	8.81E-88 5.81E-88	8.648E-88	7.996-88	CH-1
	ADIANCE (WA	1.885-82 1.885-82	1.88E-82 1.88E-82	1.88E-82	1.89E-82	1.81E-92 1.81E-82	1.21E-82	1.01E-82	1.82E-82 1.82E-82	1.826-82	• 115.19
·	PATH SCA TOT (CM-1)	3.85E-87 3.85E-87	3.85E-87 3.85E-87	3.85E-87 3.85E-87	3.855-87	3.85E-87 3.85E-87	3.85E-87	3.85E-87 3.85E-87	3.86E-87 3.86E-87	3.865-87	8268 CH-1 .
	IDIANCE (MICRN)	1.72E-35 1.64E-35	1.576-35	1.435-35	1.306-35	1.196-35	1.885-35 1.835-35	9.856-36	8.99£-36 8.58E-36	8.20E-36	FROMISIES TOIL
	ATHOS RADIANCE	5.26E-48 5.01E-48	4.585-48	4.348-48	3.95E-4E 3.77E-40	3.59E-48	3.276-48	2.975-48	2.78E-48	2.46E-40	ABSORPTION FROM
	WAVLEN	to to	555.	. 551 155	. 551 553	558	8. 8.48. 9.49.	675	.548	548	TED ABSOR
	F#E0 (CH-1)	18186.	18128.	19146	18166.	18132.	1824F.	18228.	1824F. 1825F.	18268.	IMTEGRATED
						C-37	,				

18188.8 CM-1

3.858E-87 WATTS CM-2 STER-1 (CM-1)-1 AT . 88 K . 686

4.881E-85 WATTS CM-2 STER-1 3.845E-E7 WATTS CM-2 STER-1 (CM-1)-1 AT

INTEGRATED RADIANCE .

16.43.38.UCLP. AA. LPZ

TABLE C-5
LOWTRAN OUTPUT FOR CASE 4

	. 686			369. BBB					SEASOR	SPRING-SUMMER SPRING-SUMMER						
_	7	52		٠,						LEVEL						
. 408	. 850	888		. 888						AT SEA RATO						
· 新春春	. 688	. 888		. 6188					PROFILE	TROPOSPHERIC BACKGROUND STI			NORTH MGRTH			
*	. 808	828		888			ING						4 F.			MICROMETERS) MICROMETERS)
8	<b>5</b> 9	. 888		888	. 888	SCATTERNG	SCATTERING	STANDARD STANDARD STANDARD	TVPE	RURAL TROPOSPHERIC BACKGROUND STRATO METEORIC DUST		SUMMARY	BB DEG EAST OF BB DEG EAST OF BB GREENWICH			.55 MICH
<b>6</b> 9	G: 8	180	6	50	91		USING MULTIPLE	962 U S 962 U S 962 U S	AEROSOL	RURAL TROPOSPH BACKGROL METEORIC		PARAMETERS SUM	6.8 6.8 6.8 6.8 6.8 6.8 6.8 7.8 7.8 7.8 8 8 8 8 8 8 8 8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 8 7.8 7.	_	4.1	~~
		948.		68.888	. 88	+20	<u>و</u> 2		_	_	(9 <b>(9</b>	ME		35	BASE	
2	<b>69</b>		-	6.8	18268.000	NCE		49.00		7 X 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	**************************************	PAR.		IS THE	DATA	555
2	5	8	~	٠.		RADIANCE+SOLAR	DONE	400		(2-18KM) (2-18KM) (18-38KM) (38-188KM)	22.22.22.22.22.22.22.22.22.22.22.22.22.	CONTROL	± , .			8186 8 8266 8 18 8
		.890		. 808	868		918			YER GACE	9 5 G	ONT	THUT THE PER YEAR	A C.E.	Ξ	181
ب	7	<b>9</b> 2	~		18188	COMPUTE	WILL B	ATMOSPHERIC MODEL TEMPERATURE WATER VAPOR OZONE	ш	BOUNDARY LAVER TROPOSPHERE (2 STRATOSPHERE (1)	10 42	SCATTERING CO	VE AZZENIT	N SOURCE	FROM MIE	щ
:	* * *	* * * * * * * * * * * * * * * * * * * *	:	4	:			TEMPER VATER OZONE	MODEL REGIME	P B B B B B B B B B B B B B B B B B B B	HH HI HI HI HI HI HI HI HI HI HI HI HI H	TTER	1444 444 440 440	STIA	101	ANG
÷	:	;	3A1****	3A2***	:	NIEL .	110	ER 1		BEN2 OKLE	AHH HHAN BEAN LETAN	SCA.	RELA SOLA TIME PATH DAY	RE!	F UNCTION	2 C Z Z
-	N	m			•	RAN H	31°	S. T.	SOL		<u> </u>			13.1		E
CARD	CARD	CARD	CARD	CARD	CARD	PROGRAM	CALCULATIONS	ATHO	AEROSOL		SLANT PATH H12 H22 H22 AMC AMC AMC BEF	SINGLE		EXTRATERRESTIAL	PHASE	FREQUENCY RANGE V1 - V2 - DV -

	ATM CM/KM)	2.528E-83 2.528E-83 2.528E-83	2.333E-Ø3 2.147E-Ø3 2.147E-Ø3	2.188E-83 2.287E-83 2.427E-83	3.313E-83 4.268E-83 6.867E-83	7.467E-03 7.932-03 8.867E-03	9.80#E-03 1.12#E-02 1.307E-#2	1.493E-82 1.633E-82 1.773E-82	1.773E-#2 1.826E-#2 1.773E-#2	1.698E-#2 1.587E-#2 9.333E-#3	5.133E-#3 2.287E-#3 7.933E-#4	1.867E-84 4.813E-86 2.887E-89
	K-1 (-)	2.774E-84 2.519E-84 2.281E-84	2.861E-84 1.857E-84 1.675E-84	1.497E-84 1.338E-64 1.192E-64	1.859E-04 9.376E-85 8.272E-85	7.073E-05 6.045E-05 5.166E-05	4,4155-85 3,7746-85 3,2276-85	2.758E-85 2.358E-85 2.816E-85	1.717E-85 1.463E-85 1.247E-85	1.864E-85 9.888E-86 4.175E-85	1,928E-86 9,859E-87 4,459E-87	2.328E-07 1.985E-08 1.132E-10
	MOL SCAT	9.475E-Ø1 8.5Ø1E-Ø1 7.788E-Ø1	7.835E-01 5.348E-81 5.698E-81	5.188E-81 4.566E-81 4.869E-81	3.615E-01 3.199E-01 2.823E-01	2.413E-01 2.063E-01 1.763E-01	1.507E-91 1.288E-01 1.101E-01	9.411E-02 8.945E-02 6.878E-02	5.859E-02 4.991E-02 4.256E-82	3.632E-02 3.101E-02 1.425E-02	6.558E-83 3.891E-83 1.521E-83	7.945E-84 6.773E-85 3.861E-07
	CNTMSLF MOL/CM2 KH	1.569E+28 7.951E+19 3.791E+19	1.460E+19 5.454E+18 1.846E+18	6.508E+17 1.988E+17 6.490E+15	9.537E+15 1.46ØE+15 3.Ø31E+14	6.178E+13 1.468E+13 3.188E+12	2.337E+12 1.677E+12 1.219E+12	8.726E+11 8.726E+11 8.726E+11	1.038E+12 1.219F+12 1.464E+12	1.677E+12 1.963E+12 6.5ØBE+11	1.154E+11 2.823E+18 4.615E+89	6.498E+88 1.814E+85 4.587E+88
	S) N2 ()	7.378E-#1 6.01#E-#1 4.870E-01	3.927E-B1 3.15ØE-B1 2.513E-81	1.994E-01 1.572E-01 1.232E-01	9.586E-82 7.483E-82 5.678E-82	4.150E-02 3.031E-02 2.214E-02	1.617E-82 1.181E-82 8.637E-83	6.311E-03 4.612E-03 3.371E-03	2.451E-83 1.783F-63 1.299E-63	9.483E-84 6.929E-84 I.479E-84	3.193E-#5 7.318E-#6 1.821E-#6	5.827E-87 3.291E-89 1.846E-13
	O3 TAN UNIT	2.493E-83 2.387E-83 2.284E-83	2.828E-83 1.774E-83 1.692E-83	1.576E-83 1.632E-83 1.645E-83	2.138E-83 2.557E-83 3.493E-83	4.037E-03 4.028E-03 4.228E-03	4.388E-03 4.710E-03 5.161E-03	5.54BE-B3 5.691E-23 5.8B3E-23	5.447E-83 5.248E-83 4.882E-83	4.274E-83 3.792E-83 1.542E-83	6.674E-84 2.227E-94 5.881E-85	1.872E-85 8.259E-88 5.188E-12
	CO2+	9.285E-Ø1 7.771E-Ø1 6.474E-Ø1	5,371E-#1 4,435E-#1 3,646E-#1	2.982E-#1 2.427E-#1 1.963E-#1	1.579E-B1 1.262E-B1 1.8B2E-B1	7.619E-82 5.788E-82 4.397E-82	3.340E-82 2.537E-82 1.929E-82	1.466E-82 1.114E-22 8.478E-83	6.486E-83 4.847E-83 3.675E-83	2.789E-#3 2.119E-#3 5.476E-#4	1.429E-84 3.922E-85 1.157E-85	3.747E-86 4.668E-88 5.428E-12
	H20 (SC	5.758E-Ø1 3.719E-Ø1 2.323E-Ø1	1.3025-01 7.1665-82 3.7455-82	1.9926-82 9.8346-83 5.8846-83	1.703E-03 5.894E-84 2.367E-04	9.275E-05 3.917E-05 1.587E-05	1.181E-85 0.687E-86 6.432E-85	4.726E-86 4.184E-86 3.564E-86	3.371E-86 3.168E-86 3.0155-86	2.8Ø3E-Ø6 2.636E-Ø6 7.612E-Ø7	1.624E-B7 3.549E-88 9.176E-89	1.9396-89 2.4866-12 1.5826-16
	<b>⊢</b> \$	288.2 281.7 275.2	268.7 262.2 255.7	249,2	223.7	216.7	216.7 215.7 216.7	216.7 216.7 216.7	217.6 218.5 219.6	228.6 221.6 226.5	236.5 258.4 264.2	278.7 219.7 216.8
PROFILES	A PR	1813.682 898.888 795.888	781.288 516.688 548.588	472.288 411.188 356.588	388.888 265.888 227.886	194.000 165.800 141.700	121.180 183.580 88.588	75.65 <i>8</i> 64.67 <i>8</i> 55.29 <i>8</i>	47.298 48.478 34.678	29.728 25.49# 11.978	5.746 2.871	. 798 . 855 . 888
HERIC	2 (XX)	1.68	3.88 5.88	6.88 7.80 8.8	9.88	12.00 13.00 14.80	15.88 15.88	18.88 19.88	21.88 22.80 23.88	24.88 25.88 38.88	35.88 4.8.88 45.88	58.88 78.88
ATMOSP		~ N M	<b>~</b> m •	~ co en	9=11	61 41 61	9 6	19 26	223	25 25 72	67 67 ES	325

of Assessan Passass (Passass) (Passass) (Passass) (Passass) (Passass) (Passass) (Passass) (Passass)

TABLE C-5 (Cont).

ATMOS	PHERIC	PROF IL	Si.										
	(KM)	v. ∰	_	<b>⊢</b> 3	CNTMFRN MOL/CM2 KM	HNO3 ATM CM/KM	AEROSOL 1	AEROSOL 2	AEROSOL 3	AEROSOL 4 {-}	AER1+RH (-)	CIERUS (-)	RH (PERCHT)
	38	1913.	888	288.2	2.0101.2	. 888E+88	7.78BE-B1	. 8885+88	. BBBE+88	. BB+388 3	.5336+81	. BBEE+BB 4	. 589E+#1
でこまちらて		898 795 7616 616	20000000000000000000000000000000000000	281.7 275.2 268.7 262.2 255.7	1.3816+22 8.143E+21 4.573E+21 2.521E+21 1.319E+21 7.025E+28	. 888 E + 88 . 888 E + 88 . 888 E + 88 . 888 E + 88 . 888 E + 88	7,7886-81 6,2186-32 9986-98 9986-98 0996-98	. 848E+88 . 788E+88 3. 468E-82 1. 858E-02 9. 3 18E-83	. 888 E + 88 . 888 E + 88 . 888 E + 88 . 888 E + 98 . 888 E + 98	. 8885 + 88 3 . 8885 + 58 3 . 8885 + 48 . 8885 + 48 . 8885 + 488	. 7776+81 . 238E+8B . 888E+8B . 888E+88 . 888E+88	99965 + 99 9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	4.986E+#1 5.291E+#1 .888E+#6 .868E+#8 .868E+##
და	7.80 8.60	411.	1.00 5.00	242.7	3.472E+28	. 6688E+88	. 888E+88	6.238E-93	. ABBE+88	. 898E+38	. BBBE + BB	. <b>Brat</b> + 488 . <b>Brac</b> + 488	. 888E+88
1.6	9.88	308.	868 888	223.3	6.823E+19 2.886E+19	3.615E-86 1.856E-85	. BBBE+33	1.878E-83	. 898E+88	. 988E+88	. BBBE + BB	. 888E+88	. 8085+88
12	11.00	227.	996	216.8	8.384E+18 3.235E+18	2.258E-#5 2.896E-#5	. 665E + 26 . 665E + 35	. Broe + 88	7.99BE-84 5.41BE-84	. 808E + 90 . 803E + 90	. BBE + BB	. BEBE+BB	. 888E + <b>86</b> . 888E + <b>88</b>
14	13.88	165.	888 788	216.7	1.345E+18 5.364E+17	2.888E-#5 2.82#E-#5	. 888E+38 . 888E+88	. 2786 + 33	5.178E-84 4.428E-84	. 4 2 3 6 5 + 8 8 . 2 3 6 5 + 8 8	. 888E+88	. 888E+89	. 9 8 8 E + <b>8 S</b>
16	15.68 16.88	121.	1 P P	216.7	3.929E+17 2.845E+17	2.712E-85 2.446E-85	. 888 E + 88	. 895E+82	3.95ØE-04 3.82ØE-94	. \$40E+08	. 882 E + 88	. 8885 + 88 . 8885 + 88	. 888E+88
18	17.86 18.88	80 1/2	5.00 B 6.5.00	216.7	2.874E+17 1.588E+17	2.282E-165 1.976E-185	. 8888E+88	. 888 E + 88 .	4.257E-84 5.288E-84	. 8 8 95 + 88	. 888E+88	. 888E+88	. 8885 + <b>88</b>
28 21 22	19.89 2.89 21.89 21.89	554 7.	65 75 75 75 75 75 75 75 75 75 75 75 75 75	216.7 216.7 217.6	1.282E+17 1.896E+17 1.819E+17	1.85#E-85 2.#63E-#5 2.168E-#5	. 888E + 88 . 888E + 88 . 688E + 68	. 888E+88 . 888E+88	5.818E-64 5.898E-84 5.828E-84	. 889E + 88 . 888E + 88 . 888E + 83	. 8385 +98 . 8886 +92 . 3885 +88	. 8885 + 83 . 8885 + 63 . 8855 + 68	. 6895 +88 . 8855 +88 . 8855 +88
23	22.88	4 (2	478 678	218.6 219.6	9.481E+16	2.896E-05	. 888E+38	. 88.5E+88	4.200E-84 3.880E-64	. 0 0 0 E + 0 0	. 8882 + 88	. 888E+88	. OUGE + BB
25	25.88	25.	7 10 10 10 10 10 10 10 10 10 10 10 10 10	221.6	8.825E+16 7.414E+16	2.179E-05 1.178E-05	. 800 E + 198	. 80 PE+1919 .	1.989E+84 1.318E-84	. 888E+88	. 883E+38	. 8865E + 88 . 888E + 32	. 8885 + 99 . 8965 + 89
7867 8867	35.66 35.66 99.94	1.67	91.42.43 12.43.43 13.43.43	226 236 258 4	1.961£+16 3.796£+15 7.582E+14	3.784E-85 1.441E-#7 3.891E-37	. 888E + 88 . 888E + 88 . 888E + 88	. 800E+08 . 800E+08 . 800E+08	3.326E-85 .008E+88 .008E+88	.088E+88 1.648E-85 7.998E-86	. 898E+88 . 888E+88 . 888E+88	. 888E+88 . 886E+88 . 808E+88	. 888E+88 . 888E+88
33.28	45.88 58.88 78.88	<del>.</del>	198	254.2	1.764E+14 3.454E+13 3.68EE+18	. 8885E+63 . 888E+83 . 868E+88	. 888E+88 . 888E+88 . 888E+88	. 0002+00 . 000E+00 . 000E+00	. 000E+88	4.018E-06 2.188E-86 1.688E-87	. 000E+03 . 000E+03 . 000E+80	. 868E+88 . 866E+88 . 866E+83	. 888E+88 . 888E+88 . 888E+88
33	160.69	•	999	218.8	1.399E+#6	888E+88	. 8805+88	BRBE + DR	. COBE+BB	9.3186-18	. 888E+88	. BBCE+D3	. 880E+88

CASE 2A: GIVEN HI. HZ. ANGLE

EITHER A SHORT PATH (LEN-B) OR A LONG PATH THROUGH A TANGENT MEIGHT (LEN-I) IS POSSIBLE: LEN

SLANT PATH PARAMETERS IN STANDARD FORM

TABLE C-5 (Cont).

TABLE C-5 (Cont).

	_		in in	2222	3733	333	3335	66								
RHOBAR	GM CM-3		1.17E-8 1.86E-8	9.57E-89 8.63E-86 7.77E-89 6.98E-89	6.246-18 5.576-18 4.966-18	3.89E-1	2.47E-4 2.11E-4 1.80E-4 1.54E-6	1 32E-8		NTMFRH CM-23	878+17	75E+17 47E+17 86E+17	146+19 756+18 556+18	886+18 156+18 606+19	73E+19 98F+28 15E+28	8€ + 38
BAR	Ω Ξ		4.99 8.49	- 66.99 - 69.99 - 69.99	6.98.93 3.88 6.55	8.18 6.75 6.73	6.78 6.78 6.78 6.78	6.78		300	1.1	7.44.00 7.16.7.	1.0	4.00 S	6.00	9.2
-	~		<b>83 28</b> 98 27	13 27 26 27 26 31 25 64 25	16 24 77 23 37 23 99 22	87 22 99 21 88 21	5.8 21 88 21 88 21 88 21	75 21 6.8 21 8.8 21		MSLF2 CM-2)	6£+11	5E+12 1E+12 7E+12	5€+12 2€+12 4€+13	2E+13 8E+14 7E+14	1E+15 1E+16 7E+17	0E+17
PBAR	( <b>38</b>		955.66	747.91 658.72 578.33 5,86.26	441.5 383.6 332.1 286.3	245.91 218.4 179.9	153.7 131.4 112.3 96.0	882.88 7.03.11 5.9.91		CNT	8.72	1.74 2.78 4.21	6.2 <i>8</i> 8.94 1.64	2.888 9.36	5.24 3.41 1.53	5.34
BENDING	(056)		966	. 888 . 888 . 888 . 868	888 888 888 888	888 888 888	888 888 888 888	888 888 888 888		CNTMSLF1	8.726E+11	1.745E+12 2.781E+12 4.217E+12	6.286E+12 8.942E+12 1.644E+13	4.912E+13 2.888E+14 9.367E+14	5.241E+15 3.411E+16 1.537E+17	5.348E+17
DBEND	(DEG)		988.	. 688 . 688 . 688	. 888 888 888 888	488. 988. 888.	9.00 9.00 9.00 9.00 9.00 9.00	8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.		O3 UV	3E - 182	7E-82 7E-82 8E-82	36 - 82 36 - 82 36 - 82	3E - 02 5E - 01 6E - 01	4E-81 3E-81 6E-81	86-81
H	(DEG)		8.3 . 6.66 8.8 . 6.66	88.888 88.888 88.888 89.888	88.898 88.868 88.888	8.8.88.888 88.888	88.898 86.898 86.998 86.988	88.888 86.888 88.888		{AT	1.78	3.26 4.66 5.88	6.93 7.86 8.78	9.47	1.13	1.17
ETA	EG.		888 1:	888 11 888 11 888 11	33 35 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	999 1 999 1 996 1	999 1 996 1 996 1	666 1 666 1 666 1		HNO3	57E-05	70E-85 57E-85 79E-05	865-84 625-84 475-84	37E-04 94E-04 68E-84	31E-84 49E-64 49E-64	49E-94
ã	ē		77	7777	777.		• • • •	• • •		(AT	1.9	e. e. e	1.3	2.1	2.7	2.4
DBETA	(0EG)		. 888	888 888 888 888	868. 888. 888.	998 998 898	8888 8888 8888 8888	. 888 888 888	10 2	15)	5.7476-83	1.136E-02 1.671E-02 2.165E-02	2.628E-82 3.851E-82 3.463E-82	3.867E-02 4.243E-02 4.544E-02	4.780E-02 4.969E-02 5.133E-02	5.293E-B2
ANGE	K W		988	9 9 9 8 9 9 9 9 9 9 9 9	999 999 999	888 888 888	988 988 988 988	966 966 966	œ H	F UNIT	ب س	.,,,,,	~		~~~	<b>6</b> 5
à			7	e a m n	V B 6 2	132	115	118	ATH FR	CO2 OWTRA	45E-0	57E-8 44E-8 63E-8	83E-8 93E-8	65E-0 142E-8 69E-8	183E-18 147E-18 134E-18	.53E+B
DRANGE	(KM)		1.888	1.888 1.888 1.888	1.888 1.886 1.886	1.888 1.888 1.888	1.888 1.888 1.828 1.883	1.888 1.888 1.888	THE PA	ALED L	9.7	3.9	9.0	4.64	5.6 7.6 9.8	1.2
THETA	(980)		988	988 988 988 988 988	. 688 686 686 688 688	6.69 6.69 6.69 6.69 6.69	988. 988. 988.	888. 888. 888.	NTS FOR	H20 (SC	.828E-86	.2356-06 .3776-05 .1276-05	. 1446 - 05 . 5186 - 05 . 0976 - 05	.3316-84 .8685-84 .7345-84	.723E-#3 .785E-03 .193E-02	.622E-@2
	_		88	2 2 2 2 2 2 2 2 2 2 2 2	20 50 50 50 50 50 50 50 50	57 52 53 53 55 55	6 6 6 6 6 6 6 6 6 6	64 0 0 60 0 0	R AMOUNT	۵.	3	76 B 77 1 75 2	E 67	7.6 1 2 2 2 2 1 9 6	55 2 4 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	2 88
TITUDE	(¥ ¥ (¥	0 H1	1.02	E 4 N O	9.69 9.86 18.81	11.86	14.86 15.86 16.96	18.86 19.06 28.86	SORBE	78A)	216.7	216.7	216.7	216	226. 233.6 239.	246.6
ALTI	FROM (KM.)	H2 T	. 888 1.886	2.886 3.086 4.686 5.088	6.888 7.6888 8.888 9.888	18.888 11.888 12.588	13.888 14.888 15.888 16.838	17.888 18.888 19.888	LATIVE AB	Z (F.R.)	19.000	18.888 17.888 16.888	15.600 14.880 13.686	12.406 11.688 18.888	9.000 8.000 7.600	6.000
•			<b>→ 7</b>	ო⊸ოი	7 8 6 <b>6</b>	325	4.04.7	18	EUMUL	ی		Nw4	265	8 6 8	112	<u> </u>

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

1.601E+18 1.904E+21 5.012E+18 3.760E+21	1.288E+19 7.205E+21 2.918E+19 1.339E+22 5.649E+19 2.378E+22	9.131E+19 4.007E+22						
1.681£+18 1. 5.012£+18 5.	1.43£E+19 1. 3.873E+19 2.	2.087E+2# 9.	CIRRUS	. BBBE+BB	.000E+900. .000E+900. .000E+900.	.009E+98 .009E+98 .009E+98	. 868E+B8 . 888E+B8 . 888E+B8	. 80.9E + 28 . 80.9E + 88 . 888E + 80
1.199E-Ø1 1.6	1.243E-Ø1 1 1.267E-Ø1 3	1.318E-01 2.4	AER A	BOBE+BB	. BUSE + 88 . BUSE + 88 . BUSE + 88 . BUSE + 88	. 868E + 88 . 868E + 88 . 686E + 68 . 886E + 68	. 888E + 88 . 888E + 88 . 888E + 88	. 888E + 88 . 888E + 88 . 688E + 88
2.449E-Ø4 1.	2.449E-84 1. 2.449E-84 1. 2.449E-04 1.	2.449E-84 1.	AER 3	5.8585-84	1.136E-#3 1.688E-#3 2.812E-#3 2.488E-#3	2.818E-83 3.297E-83 3.873E-83 4.598E-83	5.550E-#3 6.120E-#3 6.120E-#3 6.120E-#3	6,120E-03 6,120E-03 6,120E-03 6,120E-03
5.456E-82 2 5.638E-82 2	5.819E-02 2 6.031E-02 2 6.268E-02 2	6.512E-82 2	AER 2	. 000€+00	. 000E + 30 . 000E + 80 . 868E + 80 . 868E + 80	. 300E + 03 . 900E + 03 . 900E + 03	. 0000E+000 9.100E-004 3.426E-003 8.080E-003	1,502E-02 2,351E-02 3,689E-02 6,261E-02
1.583E+ØØ 5 1.986E+ØØ 5	2.475E+00 5 3.865E+00 6 3.776E+00 6	4.626E+888 6	AER 1	. 888E+88	. 888E+88 . 888E+88 . 888E+88	8695. 8885. 8885. 8885. 8885.	. 868E+88 . 868E+88 . 868E+88 . 868E+98	. 000E+00 . 000E+00 . 000E+00
5.399E-02 1 1.867E-01 1	2.847E-81 2.3.811E-81 3.6.778E-8) 3	1.144E+88 4	MOL SCAT	7.446E-#2	1.616E-01 2.635E-01 3.826E-01 5.221E-01	6.852E-#1 8.761E-#1 1.899E+## 1.361E+##	1.661E+88 2.982E+88 2.985E+88 2.817E+88	3.300E+00 3.840E+00 4.441E+00 5.109E+00
252.50 5. 258.99 1.	265.49 2. 271.99 3. 278.49 6.	284.99	N2 CONT	3.959E-#3	9.376E-03 1.679E-02 2.693E-82 4.081E-52	5.981E-82 8.587E-82 1.214E-81 1.782E-81	2.352E-@1 3.197E-B1 4.286E-Ø1 5.681E-Ø1	7.456E-01 9.790E-01 1.252E+80
5.000	3.888 2.888 1.008	. 688	Z (KM)	19.000	18.868 17.688 16.868	14.000 13.000 12.000 11.000	16.668 9.666 8.566	5.888 5.888 4.688
9	17	5.6	c	-	v w → vì	<b>3</b> × 8 9	3.7.7	4 5 9 1

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GEOMETRY CALCULATION	26.888 .888	188.888 28.888 898 898	
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포	N	ANGLE RANGE BETA PHI	22 22 22 22 22 22 22 22 22 22 22 22 22
6	17 17	45.62	≆ = -
UMMARY OF THE			

CNTMFRN (MOL CM-2) CNTMSLF2 CNTMSLF1 O3 UV (ATM CM) EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS H20 CO2+ D3 (SCALED LOWTRAN UNITS)

TESCATERING POINT TO SOURCE PATHER  SCATTERING POINT PAT		-	1.144E+00	9.4	4.626E+8B		6.512E- <b>0</b> 2	2.449E-84	E-84	1.318E-B1	E-91	2.887E+28	9.131E+19	4.887E+22
1.252E+08 7.571E+08 1.882E+08 7.991E-02 6.128E-03 .809E+08 .800E+08	_	N2 CONT	MOL	SCAT		AER 1	AE		AER			CIRRUS	MEAN RH	
LE SCATTERING POINT TO SOURCE PATHS  R SCITR SUBTENDED SOLAR PEATH PELATIVE SCITR MOLECULAR  SOLAR PATH PELATIVE SCITR MOLECULAR  SOLAR PETH PELATIVE SCITR MOLECULAR  SOLAR PATH PELATIVE SCITR MOLECULAR  SOLAR BE BE BE BE BE BE SOLAR THE SILVE SCITR MOLECULAR  SOLAR BE BE BE BE BE SOLAR THE SILVE SCITR MOLECULAR  SOLAR BE BE BE BE BE SOLAR THE SILVE SCITR MOLECULAR  SOLAR BE BE BE BE BE SOLAR THE SILVE SCITR MOLECULAR  SOLAR BE BE BE BE BE SOLAR THE SILVE SCITR MOLECULAR  SOLAR BE BE BE BE SOLAR THE SILVE SCITR MOLECULAR  SOLAR BE BE BE BE SOLAR THE SILVE SCITR THE SCITR THE		က	. 252E+ØB	7.5	71E+B		1.882E+88		E-32	6.1206	£-193	. BBBE+BB	. BBBE + BB	14.25
15.88	INGLE SC CTTR SCT DINT AL	CATTE	RING POIN UBTENDED ANGLE	SOLAF ZENITA	SOURC H ZE	E PATA	PELATIVE AZIMUTH		MOLE	CULAR E F				
18.88		88		6.8.86 68.88		88		120.00	.748E	-81				
16.89		88		60.09 60.09		98	pq	120.00 120.00	.748E	-Ø1 -Ø1				
13.88		6 6 6		66.98 68.98 68.68		88		128.88	748E	10-				
10.66 .68 60.06 188.06 1 126.66 .748E-81 88.06 60.06 188.06 1 126.66 748E-81 7.8E-81 7.8E 81 126.66 748E-81 7.8E 81 7.8E 81 126.66 748E-81 7.8E-81		88		5.0 .03 6.0 .03 6.8 .03			d free free free	126.86 126.86	748E	5 5 5				
4.88 .08 60.00 180.84 1 120.00 748E-61 2.88 .08 60.00 180.89 1 120.00 748E-81 1.68 .07 60.00 180.89 1 120.00 748E-81 1.68 .02 60.00 180.80 1 120.00 748E-81 20. GIVEN HI, H2, BETA.  ATE AROUND ANGLE UNTIL BETA CONVERGES  ANGLE BETA .08ETA	-			66 66 66 66 66 66 66 66 66 66 66 66 66				126.86 128.86 128.88 128.88 128.88	7486 7486 7486 7486	24 62 62 62 62 62 11 11 11 11 11 11				
ATE AROUND ANGLE UNTIL BETA CONVERGES  ANGLE BETA DBETA RANGE HMIN PHI (DEG) (KM) (KM) (DEG) (BEG) (KM) (KM) (DEG) (BERO BERO BECHBE BEE BEE 188 0000		86888		68.88 68.88 68.88 68.88 68.88			Free (see (see (see	126.66 126.66 126.88 126.86	748E 748E 748E					
ANGLE BETA DBETA RANGE HMIN PHI (DEG.) (DEG.) (KM.) (KM.) (DEG.) (BEG.) (KM.) (KM.) (DEG.) (BEG.) (BEG.) (BEG.) (BEG.) (BEG.)	ASE 20, TERATE A	GIVE	4 HI. HZ. 1 ANGLE UI	BETA NTIL B	å, JETA (	CONVE	<i>ຮ</i> າ ພ ຂ							
. 8688 . 1887 . 1888 .	₹~	010 E	_		DBET.	_	RANGE (KH)	HMIN		)EG)	BENC 1DE	)		
		8668	• •	1 D	199		189.888	. 866		0000	30	9.81 9.81		

SLANT PATH PARAMETERS IN STANDERS FORM

	100.000 KM .000 KM 180.000 DEG	
¥ د		•
HA NA	H1 H2 Angle	E E E E E E E E E E E E E E E E E E E

TABLE C-5 (Cont).

	AR RHOBAR	.99 1.17E-88 .99 9.57E-84 .99 9.57E-84 .99 7.7E-84 .58 6.98E-84 .58 6.28E-84	58 5.57E-84 55 4.96E-84 55 4.89E-84 7.75 3.38E-84 7.75 3.28E-84	7.00 1.35 E	.89 5.89E-8 .89 5.89E-8 .73 2.79E-8	.52 5.95E-8 .63 2.86E-8 .92 3.81E-8	.85 1.58E-88	CNTMFRN (MOL CM-2)
	PBAR TBA (MB) (K)	955.693 234 747.913 271 558.727 265 578.391 258 566.204 252	332.137 233 236.389 226 245.987 226 216.499 216 179.988 216	7905 3 21 2 2 3 2 2 3 2 3 2 2 3 2 3 2 2 3 2 3	7.572 21 2.197 22 7.687 22 8.88 <i>B</i> 23	22 24 97 25 46 25 16 25	.#28 217	CNTMSLF2 (MOL CM-2)
	BENDING (DEG)	######################################		අයත් පටනුව අත්ත් ප්ලාවේඛ	. 68 88 88 88 88 88 88 88 88 88 88 88 88	PO 20 20 20 1	88	CNTMSLF1
	DBEND (DEG)	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	\$	1 <b>6</b> 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	60 60 60	888.	S UV CM) CM
	PH1 (DEG)	188.888 188.888 188.888 188.888 188.888 188.888	186.868 188.868 188.868 188.868 188.868 188.868		ନ ପ୍ରଥମ ଅନ୍ତର୍ଶ	88 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	18 <i>8.8</i> 0	3 (ATM
	8E7A	888 888 888 888 888		අවසුත් ප්පත්ව අවසුත් ප්		6 6 6 6	50 50 50	CATM CM
IOS P.E.R.E.	DBETA (DEG)	888 888 888 888 888 888 888 888 888	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$		. 200 200 200 200 200 200 200	6. 6.6. 6.6. 6.6. 6.6. 6.6. 6.6. 6.6.	. ##6 TO Z	5) 03
H 7HE ATM	RANGE (KM)	3.988 3.988 3.988 5.988 7.988	9.0000 11.00000 11.00000 12.0000 13.0000		வ சுவத்வ சுவ்வன்	9 00 00 00 00 00 00 00 00 00	188.888 FROM HI	2+ AN UNI
H THROUG	DRANGE (KM)	1.868 1.868 1.888 1.888 1.888		. அமைக்க க <i>ம்</i> .	9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	5.888 5.888 5.888 8.888	38.888	CO.
ACTED PAT	THETA (DEG)			00000 00000 00000 00000 00000 00000	999 999 9999 9999	60 60 60	. BBB. AMOUNTS FOR	H20 (SC.
; ; REFR	717UDE 10 (KM) TO H1	2.0000 3.0000 3.0000 5.0000 5.0000 7.0000 7.0000	8.000 9.000 113.000 11.000 11.000 112.000	7 - 10 - 10 - 10 - 10 - 10 - 10 - 10 - 1	5 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	4.0.00 45.00 50.00 70.00	188.888 Sorber AMC	TBAR (X)
CULATION OF	ALTITI FROM (KR) H2 TO	1.2 2.0 2.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3	7.000 9.000 10.000 10.100 11.000 11.000 11.000 11.000 11.000 11.000	. 0.00 0.00	N m ≠ 10 pg	5.868 8.888 8.888 8.688	79.898 1 ULATIVE ABS	Z (KM)
CALCU	**	-NE 489K	8008- NE41	0 27 80 8 - 20 0 27 80 8 - 20	22 24 25 26		35 35	ŋ
				C-45				

TABLE C-5 (Cont).

91E+15 196E+16	151E+17 122E+17 162E+17	171E+17 158E+17 287E+17	194E+17 183E+17 55E+18	35E+18	876E+18 229E+18 864E+19	.432E+19 .145E+19 .697E+2#	122E+28 163E+28 195E+21	61E+21 86E+21 139E+22	178E+22 187E+22					
2.1.0	20.04		9.7	2.7	E 23 -	2.7	1.9	W/-	2.3					
. 357E+13 . 357E+11 . 883E+12	7.827E+12 9.647E+12 1.122E+13	.256E+13 .369E+13 .464E+13	.552E+13 .639E+13 .742E+13	.886E+13 .Ø85E+13	.188E+13 .376E+13 .154E+14	.514E+14 .255E+15 .413E+16	.517E+17 .349E+17 .681E+18	5.Ø12E+18 1.28BE+19 2.918E+19	.649E+19					
1 3 1 2 2 1 2 2 1 2 3 1 1 2 1 2 1 2 1 2	308	233		393		4 10 00 € 10 00 00	7 7 5	60 en er.	19 5 28 9	RRUS	E + 1919 + 1919 + 1919 + 1919 + 1919	E + 1919 E + 1919 E + 1919 E + 1919	E + 13 8 + 14 8 8 + 14 8 8 + 18 8 + 18 8	E + 19.0 E + 19.0 E + 19.0 E + 19.0
6.443E+1 3.377E+1 1.885E+1	7.829E+1 9.649E+1 1.122E+1	1.256E+1 1.369E+1 1.465E+1	1.552E+1 1.639E+1 1.743E+1	1.886E+1 2.885E+1 2.359E+1	3.1886+1 6.3766+1 2.154E+1	9.514E+1 5.255E+1 3.413E+1	1.537E+1 5.349E+1 1.681E+1	5.012E+1 1.430E+1 3.873E+1	9.489E+1 2.857E+2	13		. 202 . 203 . 203 . 203	9688 8688 8688 8688	888. 889. 886.
222									<del></del>	₹ 24	E - 187	2001 2001 2000	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	E - 34
.912E-83	1.244E-8 1.487E-8 1.588E-8	1.768E-8 1.939E-8 2.117E-8	2.287E-8 2.443E-8 2.583E-8	2.785E-8 2.818E-8 2.983E-8	2.987E-8 3.864E-8 3.132E-8	3.183E-8 3.221E-8 3.249E-8	.273E-8 .295E-8	3.350E-8 3.350E-8 3.384E-8	3,489E-8 3,434E-8	AEI	9.272 1.688 3.876 5.963	1.591	1.55	1.591 1.591 1.591
689 1					444		W W W	242	•••	m ~	E + 1919 E + 1919 E + 1919	F : F : F : F : F : F : F : F : F : F :	E E E E E E E E E E E E E E E E E E E	H L I I I I I I I I I I I I I I I I I I
7.727E-3: 1.855E-88 5.493E-86	4.848E-89 5.664E-89 7.864E-89	1.215E-B	1.622E-0	2.254E-B	3.874E-9/ 3.363E-6/ 3.621E-6/	3.787E-0. 3.858E-0. 3.876E-8	3.876E-8. 3.876E-8. 3.876E-8.	3.876E-01 3.876E-01 3.876E-01	3.876E-#1 3.876E-#1	AER	9889	. 6888 8.388 4.392 5.63.5	1.2046 1.5046 1.6636 2.2086	2.7938 3.3438 3.8166
<b>*</b> € 00 00	222		202	~~~	200					2	E + 1919 E + 1919 E + 1919 E + 1919	E + + + + + + + + + + + + + + + + + + +	F + + + + + + + + + + + + + + + + + + +	######################################
8.38E-8 8.238E-8	2.511E-8 2.511E-8	3.466E-02 4.801E-02 4.563E-02	5.138E-03 5.700E-03 6.235E-03	6.728E-07 7.183E-07 7.614E-07	8.430E-03 8.430E-03 8.807E-03	9.105E-02 9.343E-02 9.532E-02	9.696E-02 9.856E-02 1.002E-01	1.019E-0 1.038E-0 1.060E-0	1.883E-8	AEI	. 688 . 688 . 688 . 688	2000 2000 2000 2000 2000 2000 2000 200	9888. 9888. 9889.	8.50 8.80 8.80 8.80 8.80 8.80 8.80 8.80
*****	innin		272	<b>.</b>			<b>6</b> 69 69		50 50 50 50	-	E+98 E+98 E+98 E+98	F + + + + + + + + + + + + + + + + + + +	E + 1919 E + 1919 E + 1919	H H H H H H H H H H H H H H H H H H H
1.658E-81 5.659E-81 2.872E-83	7.878E-8 1.832E-8 1.353E-8	1.776E-02 2.335E-02 3.074E-02	4.849E-83 5.331E-83 7.818E-83	9.237E-87 1.216E-81 1.688E-81	2.106E-81 2.772E-81 3.649E-81	4,776E-81 6,191E-81 7,955E-83	1.814_+86 1.284E+96 1.614E+96	2.817E+88 2.585E+88 3.896E+88	3.885E+92	AER	9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	2000 2000 2000 2000 2000 2000	20 C C C C C C C C C C C C C C C C C C C	9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
7.7.8	ស៊ីស៊ីស	68 65 65 65	សសស	សិសិសិ	ற்குத	4 m m	นทห		<b> 6</b> 0	SCAT	E - 03 4 E - 03 2 E - 03 2 E - 03 2	E-82 E-81 E-81	E - 611	11 11 11 11 11 11 11 11 11 11 11 11 11
1.263E-Ø 5.436E-Ø 2.482E-Ø	1.883E-8 1.275E-8 1.566E-6	1.875E-8 2.202E-0 2.548E-0	2.931E-Ø 3.372E-Ø 3.925E-Ø	4.676E-8 5.693E-87 7.867E-8	9.646E-#5 1.586E-#4 3.123E-#4	5.9892-8 1.748E-8	1.196E-B 2.625E-B 5.402E-0	2.848E-8 3.811E-8	6.778E-Ø	MOLS	3.918 6.294 1.189 2.296	4.599 9.551 2.833 2.369	3.224 3.224 3.765 4.465	5.145 6.036 7.035 8.227
<b>6000</b>	നമഹ		80,80,80	000	Ø Ø 40	er 20 ge	666	கைக	6. g.	FNO	999	11111111111111111111111111111111111111	20 60 60 60 60 60 60 60 61 61 61 61 61 61 61 61 61	E - 1917
255.4 242.5 238.8	223.7 221.8 228.8	219.89 218.89 217.14	216.71 216.71 216.71	216.76 216.76 216.71	216.74 216.74 216.74	228.11 226.59 233.80	239.56 246.86 252.56	258.9 265.4 271.9	278.45	N2 C(	9.534E- 1.996E- 7.117E- 2.688E-	1.1848 4.8868 2.2538 3.8678	4.181E 5.718E 7.879E 1.878E	2. 455 2. 488 3. 753E
15.686 35.686 38.686	25.838 24.868 23.886	22.888 21.888 26.888	19.888 18.888 17.888	16.988 15.888 14.888	13.888 12.888 11.888	14.848 9.638 8.888	7.888 6.886 5.888	4.000 3.606 2.688	1.00C	Z (	76.888 58.888 45.888 48.888	35.888 38.888 25.888 24.888	23.826 22.06 21.00 28.886	19.070 18.880 17.088 16.888
<b>⇔</b> ល ល	V @ 0	1.0	15	16	19 28 21	22 23 24	25 25 27	28 29 30	32	s	-264	no or or	111	C 4 0 0

			CNTMFRX	S	4.887E+22 MEAN RH (PRCNT)	48.25			
######################################	. 60 GE + 36 . 20 GE + 36 . 20 GE + 48 . 26 GE + 48 . 26 GE + 48		CNTMSLF2	O1 CM-2	9.131E+19 CIRRUS	. 8805+88			
4 4 4 6 - 3 10 6 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	.5916-3916-3916-3916-3916-3918-3918-318-318-318-318-318-318-318-318-318-3		CNTMSLF1	(MOL CM-2)	2.887E+28 AER 4	1.5916-84			
4. 25. 25. 25. 25. 25. 25. 25. 25. 25. 25	8.328E-03 8.328E-03 8.328E-03 8.328E-03		03 UV	(ATM CM)	3.434E-01	8.328E-#3	MOLECULAR PHASE F	6911	E-181
99 99 E + 48 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	6.261E-02 7.391E-02 7.991E-02 7.991E-02		HNO3	(ATM CM)	3.876E-84 AER 2	7.9916-02	SCTTR MOLE ANGLE PHAS	28.88 ,748E-81 28.88 ,748E-81 28.88 ,748E-81	28.88 .7486 28.88 .7486
######################################	.000E+989 3.125E-02 3.125E-81 1.002E+980	V E	03	UNITS)	1.187E-81 AER 1	1.882E+88	ATHS RELATIVE H AZIMUTH		
1. 1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	5.54 6.29 7.18 8.81 CALCUL			LOWTRAN	4.657E+88	8.812E+88	SCATTERING POINT TO SOURCE PATHS SCTTR SUBTENDED SOLAR PATH RELATIVE ALT ANGLE ZENITH ZENITH AZIMUTH	8.86 188.88 8.86 188.68 8.88 188.88	69.85 195.85 68.68 185.88
7.85166. 9.5526.03 9.5526.03 1.35896.01 2.38696.01 2.38696.01 3.3866.01 5.3886.01 5.3886.01 5.3886.01 7.3686.01	1.615E+00 2.853E+00 2.595E+00 3.262E+00 THE GEOMETRY	PASSING SERVICE SERVIC	H20	SCALED	1.144E+88	3.262E+ØØ	TERING POINT SUBTENDED ANGLE 2	. 988. 688. 688.	20. ga 20.
1187 1189 1199 1199 1199 1199 1199 1199	2 2 2	E C E E E E E E E E E E E E E E E E E E					SINGLE SCATT SCTTR SCTTR POINT ALT	1 189.68 2 78.88 3 58.88	4 45.69 5 48.88

## TABLE C-5 (Conc).

748E-B	7495-0	748E-9	.748E-Ø1	748E-8	748E-8	748E-8	7.4	748E-\$	8	7485-9	748E-B	7485-8	748E-8	74BE-8	.748E-B1	74BE-8	748E-8	74BE-B	.748E-Ø1	748E-B	7485-8	748E-8	748E-8	748E-0	.748E-01	748E-0	748E-8
28.8	20.00	28.8	1 126.66	28.6	26.8	28.B	9.0	28.8	28.	28.8	28.8	28.9	28.8	28.8	1 120.00	20.8	20.8	28.8	1 128.98	28.8	28.8	28.8	28.99	28.8	1 128.88	28.8	28.8
88.8	9 9 9	88.68	185.88	89.8	86.8	88.8	188.88	88.8	86.8	8.8	80.0	88.6	88.6	88.8	180.60	88.6	88.8	86.4	186.90	86.8	8.8	8.9	80.5	88.8	180.08	80.0	86.6
9.	9	. 6	60.66	8	8	8.8		8.8	•	9.9	8.0	9.9	0.0	2	60.69	9.8	9.0	9	59.68	9.	Đ,	8	9.0	6	6P.8B	٠ د	9.
6	-5	5	96	5	6			9	. 83	-	6	6	8	Ē	æ.	6	0	8			BB.	-	8	10	. 88	6	t.
2			24.50					6	10		9	5	9.4	8	12.80		9	9		9		69	ō.	6	7.65	5,	8
Ç	r	- α	, o						5						21	25					<b>C1</b>				3		

## RACIANCE (VATTS / CM2 - STER - XXX )

INTEGRAL TOTAL	(CM-1) TRANS	1.71E-86 .2328 5.13E-86 .2818	9.55E-26 .2916 1.22E-25 .2813	1.54E-05 .2811 1.88E-05 .2889	2.22E-#5 .28#5 2.56E-#5 .28#5	2.90E-85 .28#3 3.24E-85 .28#8	3.58E-85 .2797 3.92E-85 .2793	4.265-85 .2798 4.62E-85 .2787	4.94E-#5 .2784 5.28E-#5 .2788	5.45E-85 .2777	
RADIANCE	(MICHA)	1.126-82 1.	1.126-02 0.	1.126-02 1.6	1.126-82 2.3 1.13E-82 2.3	1.12E-02 2.	1.13F-#2 3.	1.136-62 4.	1.13E-82 4.	1.13E-02 5.	
TOTAL R	(CH-1)	3.42E-87	3.42E-87	3.416-87	3.416-87	3.40E-07 3.44E-07	3.48E-87	3.48E-87	3.40E-87	3.406-87	
RADIANCE DIBECT	( - HO)	8.81E-08 8.79E-88	8.73E-88 8.77E-88	8.75E-88 8.74E-88	9,73E-98 8,72E-08	8.70E-83	8 . 69E -@8 8 . 68E -&8	8.67E-#8	8.55E-#8 8.64E-#8	8.635-08	
GROUND REFLECTED R	(MICRN)	4.49E-83	4.49E-03	4,48E-83	4.485-83	4.48E-83	4.48E-93	4.48E-83	4.48E-#3	4.486-83	
GROUND R	(CH-1)	1.37E-87	1,376-87 1,36E-87	1,36E-07 1,36E-07	1.3687	1.35E-87 1.35E-87	1.35E-87 1.35E-87	1.35E-07 1.35E-87	1.358-87	1.346-87	
RADIANCE	(CK-1)	4.78E-88	4.71E-28	4.71E-88	4.71E-88	4.71E-88	4.735-08	4.74E-#8	4.74E-#8	4.75E-88	19 CM-1
SCATTERED RA	(MICRN)	6,726-83	6.73E-#3 6.74E-#3	6 75E-#3 6.75E-#3	6.76E-83	6.77E-83	6.88E-#3 6.81E-#3	6.82E-#3 6.83E-#3	6.85E-#3 6.86E-#3	6.875-83	115.19
PATH SC	(04-1)	2.85£-87 2.85£-87	2.85E-87 2.85E-87	2.85E-87 2.85E-87	2.85E-47	2.856-87	2.83E-87 2.85E-87	2.85E-87 2.86E-87	2.862-87 2.86E-87	2.86E-87	T018268 CM-1
RACIANCE	CHICRNO	4.41E-35	4. P.E-35 3.83E-35	3.668-35	3.33E-35 3.16E-35	3.83E-35 2.89E-35	2.768-35	2.51E-35 2.4#E-35	2,29E-35	2.08E-35	
ATMOS R	1-10)	1.35E-39	1.226-39	1.176-30	1,181E+39	9.17E-40	8.33E-42	7.57E-48	6.87E-48 6.55E-40	6.255-40	INTEGRATED ABSORPTION FROMISISES Average transmittance = .28F1
VAVLEN	(MECRA)	ψ. Φ. α.α.	20.00	6. v	. 551 558	து து மாம் மாம்	4. 4. 4. 4.	643.	.548	.548	ATED ABS
FREG	(CM-1)	18188.	16128.	18148. 18158.	18168.	18186.	18218	18228. 18238.	1924P. 1825#.	18281	INTEGRA

18188.8 CM-1 18188.8 CM-1

5.453E-#5 WATTS CM-2 STER-1 3.483E-#7 WATTS CM-2 STER-1 (CM-1)-1 AT 3.421E-#7 WATTS CM-2 STER-1 (CM-1)-1 AT 288.2# K

INTEGRATED RADIANCE . MINIMUM RADIANCE .

MAXIMUL FABIANCE BOUNDARY TEMPERATURE BOUNDARY EMISSIVITY - 15.49.21.UCLP. AA. LPZ

CARD 5 ....